AWARD NUMBER: W81XWH-06-2-0074

TITLE: A Clinician-Centered Evaluation of the Usability of AHLTA and Automated Clinical Practice Guidelines at TAMC

PRINCIPAL INVESTIGATOR: CAPT Emory Fry

CONTRACTING ORGANIZATION: Tripler Army Medical Center
Tripler AMC, HI 96859

REPORT DATE: October 2009

TYPE OF REPORT: Annual

PREPARED FOR: U.S. Army Medical Research and Materiel Command
Fort Detrick, Maryland 21702-5012

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
1 October 2009	Annual	29 Sep 2008 – 28 Sep 2009

4. TITLE AND SUBTITLE

A Clinician-Centered Evaluation of the Usability of AHLTA and Automated Clinical Practice Guidelines at TAMC

5a. CONTRACT NUMBER

5b. GRANT NUMBER
W81XWH-06-2-0074

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

CAPT Emory Fry

E-Mail: emory.fry@med.navy.mil

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Tripler Army Medical Center
Tripler AMC, HI 96859

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Army Medical Research and Materiel Command
Fort Detrick, Maryland 21702-5012

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for Public Release; Distribution Unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

Purpose: The project will demonstrate that Clinical Decision Support (CDS) material can be retrieved from a central, shared repository and executed within the MHS and civilian health information systems to improve quality of care through the use of reminders, alerts, guidelines etc. The system design and approach will decrease guideline development time and speed translation of evidence based medicine into clinical practice. It will decrease costs and enable multiple stakeholders to work in an open content/source environment to exchange clinical content, develop and test technology and explore processes in applied CDS.

Design: Comparative study between the KMR infrastructure and capabilities developed as an open source, vendor agnostic solution for aCPG execution within AHLTA and the current DoD/MHS standard evaluating:

H1: An open source, open standard KMR and Clinical Decision Support Engine can enable organizations to share domain knowledge, expertise, and collaborate on efforts to improve patient safety and quality of care using automated clinical practice guidelines.
H2: An open standard KMR and Clinical Decision Support Engine can codify clinical practice guidelines and domain knowledge so that they can be executed without modification within a variety of runtime environments, including AHTLA and VistA.
H3: An open standard KMR and Clinical Decision Support Engine can effectively manage both generic clinical domain knowledge (guidelines, best practice, etc) and specific institutional requirements (workflow, policy, capabilities) to ensure reliable execution of a CPG across institutional boundaries.

Methodology: The KMR project architecture will leverage the emerging Federal Health Architecture (FHA) group NHIN-Connect infrastructure and its ability to provide health information exchange across a distributed network. In order to better support KMR integration and evaluation by the Office of the National Coordinator, the KMR team will coordinate and integrate the KMR project into the Agile SCRUM iterative build and test process which is in use by FHA.

15. SUBJECT TERMS
Open Source and standards based KMR and Clinical Decision Support Engine

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			USAMRMC
U	U	U	UU	109	19b. TELEPHONE NUMBER *(include area code)*

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39.18

Table of Contents

INTRODUCTION

The intent of this investigation is to develop an open source, open standard, vendor agnostic infrastructure that will enable organizations to develop and exchange Clinical Decision Support content, tools and processes. A system that improves quality of care through reminders, alerts, and guidelines would decrease development time and accelerate the introduction of new domain knowledge into clinical practice. The KMR system will demonstrate the execution of clinical practice guidelines in AHLTA and other modern health care systems, ultimately decreasing costs for providers and improving quality of care. Five categories of work guide this project:

Aim1 Engineering Documentation

a) Requirement Analysis and Project Plan;
b) System Design Specification and Academic Review

Aim 2 Implementation Of KMR Infrastructure And Delivery Of Source Code
Aim 3 Development of Executable Guidelines
Aim 4 Runtime Demonstrations
Aim 5 Comparative Evaluations & Academic Publications

BODY

Task 1: Preparatory Work For Project Initiation

- First quarter of 2009, changed Principal Investigator from LTC Do to CAPT Fry and forwarded revised Statement of Work to the sponsor.
- JAVA Engineers C. Matser and D. DeCouteau started 2/9/09.
- Revised Statement of Work dated March 16, 2009 was approved by sponsors and became effective 11 May 2009.
- Based on the new proposal and revised SOW, the Project title changed from "A Clinician-Centered Evaluation of the Usability of AHLTA and Automated Clinical Practice Guidelines at TAMC" to "Knowledge Management Repository (KMR) for Clinical Decision Support (CDS) and Proof of Concept for Automated Clinical Practice Guideline (aCPG) Execution within AHLTA".
- Location of the study was moved from Tripler Army Medical Center in Honolulu, HI to Naval Health Research Center in San Diego, CA.
- Project Director: Patricia L. Price returned to the project Jun 8, 2009.
- JAVA Engineers J. Kriseman and Mark Pitman started June 8, 2009 replacing C. Matser who left the project May 15, 2009.
- Intellectual Property SOP was reworked to be consistent with FHA-NHIN-CONNECT; Rights and Special Works language was selected and reviewed with MRMC legal.
- SOW, Budget Sub Award, and Contract Sub Award with SOADEX completed. SOADEX is providing professional services related to the documentation of functional requirements and system design documentation, software quality assurance, creating UML artifacts, and an engineering plan.

- A modification to SOW, Budget Sub Award, and Contract with SOADEX was completed allowing SOADEX to provide a "SCRUM Master", the individual who ensures that the SCRUM process is used as intended and to oversee the iterative build and test process. The Scrum Master began work the first week of October.
- The SOW, Budget Sub Award and Contract for the hosting services required to run the KMR development servers was completed between ASU and The Geneva Foundation.
- The SOW and Budget Sub Award for ASU academic deliverables was completed. The Contract for this work between ASU and The Geneva Foundation is awaiting final ASU signature.
- SOW, Budget Sub Award, and contract for Medsphere to implement, test, and integrate open source engineering deliverables for the KMR architecture was completed. The Medsphere kickoff meeting was held Oct 21, 2009.
- CRADA agreement as vehicle for indirect cost reimbursements between NHRC and Geneva was replaced with a MOU between TATRC and NHRC. TATRC will cover all CAPT Fry and Patricia Price indirect costs via MIPRS. This MOU has been approved by TATRC and is pending final approval by BUMED.
- Dr Fry met with the CIO of the Indian Health Service and with representatives from ASU in May 2009 and then again Oct 16, 2009. He secured their commitment to prepare for and then execute a limited production trial of the KMR system for the purposes of conducting usability research. With that goal in mind, ASU, NHRC, and IHS are collaborating on the creation of a community advisory board and a series of focus groups involving prospective participants. The scope of this pilot has yet to be determined – when completed, appropriate IRB submissions will be prepared. The final KMR proposal and SOW were submitted to Chris Blood, IRB Coordinator, NHRC on Oct 26, 2009 for review. Current activities center exclusively on the engineering aspects of clinical decision support, any required semantics, and the infrastructure required to support real-time decision analysis functionality. As such it neither touches nor uses live clinical data or systems. A final IRB determination will be obtained once a patient population has been identified, and a pilot hypothesis has been definitively proposed.
- Office of the National Coordinator for Health IT was briefed on the KMR project. Several Federal Agencies and academic institutions have agreed in principle to contribute requirements and review KMR designs during a weekly online meeting moderated by CAPT Fry every Thursday morning at 10am PST.

Task 2: Preparatory Engineering For Transition To New Project Proposal And Modified Statement Of Work

- The KMR team staff upgraded the existing DDSS run time system originally built using Oracle into an open source implementation and updated its MIRTH HL7 engine to latest release.
- The KMR team staff implemented a complete conversion of the NHIN CONNECT 2.1 release into a single virtual machine image using Linux and other open source

components. This image was provided to FHA as a reference Linux implementation for CONNECT customers.

- D. DeCouteau and Dr Fry attended a REDHAT workshop on the DROOLS rules engine intended to be the core inference engine in KMR. REDHAT and KMR teams have agreed to coordinate their respective development, ensuring that the DROOLS implementation in KMR meets functional and performance criteria required for enterprise scalability. This collaboration is supported in part by the Medsphere Contract.
- Dr Fry meet with Wavemaker, an open source rapid development tool company, to discuss adapting Wavemaker to help create KMR applications. WaveMaker has agreed to coordinate with the KMR team to ensure their use of WaveMaker for creating KMR applications is optimal. First application to be built using WaveMaker will be MedAlert, a key application for visualizing KMR notifications.
- Team collaboration wiki, source code repository and software defect tracking system installed and configured.
- Development, Quality Assurance, and Production environments for DDSS/KMR/NHIN infrastructures configured, and installed. SOADEX has hired a Quality Assurance expert and is scheduled to delivery system test, integration and QA plans, November 25, 2009.

Task 3: – AIM 1: Engineering Documentation

The Project Plan and a Table of Project Deliverables were completed. The KMR project is employing a SCRUM or Iterative Project Management methodology. The Scrum process is built on a series of sprints; the KMR project is composed of 41 sprints, with each sprint approximately 2 weeks in duration. (see project plan.)

- May 25, 2009, SOADEX meet with the KMR team to review requirements, documentation, and schedule. They delivered a strategy for completing the documentation and for developing the engineering plan.
- June 5, 2009 SOADEX delivered functional requirements and use cases. Weekly VTC's requirement reviews with Morningside Initiative and other select academic organizations were started and are on-going with the intent of incorporating recommendations from these meetings into these requirements and the engineering plans.
- The proposed requirements and design review that was to be held at ASU in August 2009 with Morningside Initiative and other select academic organizations was cancelled. This gathering has been rescheduled to November 14, 2009, in San Francisco, at the AMIA Conference location.

August 14, 2009, SOADEX provided a draft system document detailing system architecture, technical capabilities, and configuration requirements. This system design detailed a Service Oriented Architecture to be implemented in Java using Open Source technologies from Sun Microsystems.

Task 4: – AIM 2: Implementation of the KMR and CDS Infrastructure

There are four software releases scheduled by the Engineering Plan - Release 4 being the final release.

Release 1 began in February 2009 and will complete with Sprint 16 scheduled for November 13th. This first release will be the basis of the November 14th requirement and system design review, and the first KMR demonstration. The attached Gantt chart shows the Sprints completed, the % of work ongoing and the projected end date for each Sprint.

Engineering deliverables to date include:

An implementation of GUI Service for the KMR bus

AHLTA data access services

Provider Inbox

Refactored Clinical Decision Support Service

Initial KMR data repository schema

A policy and authorization framework for rule access control across distributed repositories

Mirth Event Service responsible for processing real-time HL7 messages.

Bus Orchestration Service to prioritize and manage access to clinical services

Task 5: – AIM 5: Comparative Research & Academic Publications

CAPT Fry is scheduled to host and present at a panel discussion on collaborative Clinical Decision Support as part of the AMIA Conference, in San Francisco, November 15, 2009.

KEY RESEARCH ACCOMPLISHMENTS

- Initial system design required to deploy run-time rule engine support for existing health information systems. This was a major architectural integration effort harmonizing existing DoD systems with the Nationwide Health Information Network.
- Initial canonical data model, based on HL7 RIM, supporting extraction of interoperable data objects from existing health information systems. This data domain model is the first publically available, standards-based data model designed to support all major EMR vendors and systems. It defines a Virtual Medical Record structure that isolates the middle tier from the data tier, thereby ensuring universal applicability. This model is a glaring deficiency in the HL7 3.0 normative release and will be submitted to HL7 and associated Standards Organizations as a candidate domain model for the Virtual Medical Record.
- Initial semantic model to support interoperable rules and guidelines using existing health information systems. This was a major semantic integration effort harmonizing existing DoD systems with the vocabularies used by the Nationwide

Health Information Network. This work provides the standards-based foundation for creating interoperable rules and logical operations.

- Identification of initial operational metadata required to ensure that clinical decision support performs safely and reliably across organizational boundaries. This is significant ontology definition effort addressing a second glaring deficiency in the HL7 3.0 normative release – the lack of terminologies / ontologies for describing clinical tasks, actions, and organizational characteristics. When completed it will be submitted to HL7 and associated Standards Organizations.

REPORTABLE OUTCOMES

Artifacts documenting the research efforts to date can be found at the following website: http://www.socraticgrid.org/wiki/documentation. Source code completed so far (100+ MB). Available upon request.

CAPT Fry presented and moderated discussion regarding KMR at the following Office of the National Coordinator meetings:

CDS Consortium & KMR Projects - 5/14/09

CDS Collaboratory quarterly meeting - 8/5/09

CDS Collaboratory Special Session - ONC CDS Workshop Report - 9/21/09

CAPT Fry was a principle author to the paper entitled "The Morningside Initiative: Collaborative Development of a Knowledge Repository to Accelerate Adoption of Clinical Decision Support" to be published in the Open Applied Informatics Journal later this year. This paper describes the collaboration with the Morningside Initiative and the need for a knowledge management repository.

CAPT Fry presented and moderated discussion regarding KMR with the staff of the Indian Health Service CIO – 10/16/09.

CAPT Fry contributed to a recently awarded AHRQ grant submitted by Thompson Reuters and a group of Federal and academic investigators to pursue research into the semantics of interoperable rules. The KMR infrastructure was a key component in the application as it enabled the investigators to demonstrate broad deployability for the new research across multiple health systems.

CAPT Fry was invited and agreed to present the KMR project at MEDINFO 2010 - 13th World Congress on Medical and Health Informatics in Cape Town, South Africa, September 12 - 15, 2010. MEDINFO 2010 is the premier international health informatics event similar to HIMSS here in the United States.

CONCLUSION:

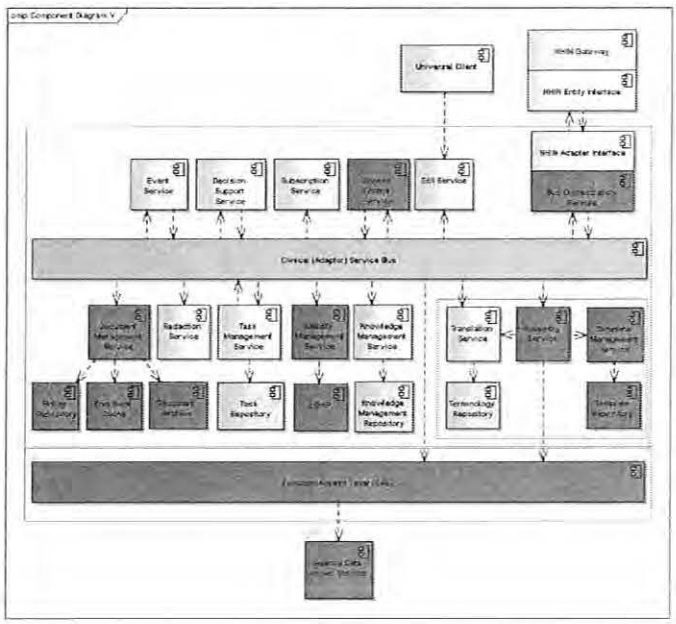
KMR is implementing a flexible, open-source solution that enables healthcare entities to realize real-time clinical decision support functionality on top of their existing health information systems. Our research to date has shown great progress in designing a fully functional infrastructure that will enable organizations to meet their clinical decision support requirements.

Based on service-oriented-architecture principles and web service interfaces, KMR enables individual components to be replaced by custom solutions as long as they adhere to the defined web service interface specifications and HL7 standards. It allows implementations to be hosted on different hardware and software platforms, as well as services to be implemented using different programming languages against different back-end systems.

KMR is layered upon the Federal Health Architecture's Messaging, Security, and Privacy Foundation that describes the underlying protocols and capabilities necessary to send and secure messages between participants on the NHIN. This Foundation implements the core NHIN Services that define the interfaces used to discover and exchange health and health-related information. KMR team members contributed significantly to this effort last year and now are providing the additional services required to deploy advanced decision support services, knowledge management, and workflow capabilities for clinical and administrative processing of local and distributed data. In general, these additions ensure that decision support, orchestration and workflow management of the entire middle tier is appropriately managed by the KMR rules engine.

KMR and its supporting services is essentially an intelligent Service Oriented Architecture for Healthcare delivering the data and services required for advanced clinical decision support and workflow optimization. It does so with particular attention to the semantic and organizational requirements for achieving and maintaining interoperable health data exchanges, and extends those semantic constraints into the realm of inter-organizational authoring, sharing and execution of clinical rules and guidelines. Being standards-based, KMR offers the first decision support infrastructure that promises to be universally implementable across the majority of commercial Electronic Medical Record systems.

Figure 1: KMR Service Oriented Architecture For Healthcare Decision Support



APPENDICES:

Appendix I "The Morningside Initiative: Collaborative Development of a Knowledge Repository to Acc4elerate Adoption of Clinical Decision Support"
Appendix II "Accelerating the Translation of Knowledge into Clinical Decision Support: Four National Demonstration Projects"
Appendix III "Hardened Rules for Clinical Decision Support"
Appendix IV "Knowledge Management Repository & Clinical Decision Support Services"
Appendix V "A Model for Sharing Knowledge and Tools for Clinical Decision Support Driven by a Use Case Requiring Interoperable Delivery in the AHLTA Environment: A Collaborative Partnership of the Morningside Initiative with the Department of Defense."
Appendix VI "KMR_Project_Plan_10-28-2009"
Appendix VII "KMR Deliverable Table September 2009"

The Morningside Initiative: Collaborative Development of a Knowledge Repository to Accelerate Adoption of Clinical Decision Support

Robert Greenes, M.D., Ph.D., Arizona State University, Phoenix, AZ
Meryl Bloomrosen, M.B.A., American Medical Informatics Association, Bethesda, MD
Nancy E. Brown-Connolly R.N., M.S., (Ph.D.c), Telemedicine and Advanced Technology Research Center (TATRC) of the US Army Medical Research Materiel Command, Frederick, MD
Clayton Curtis, M.D., Ph.D., Veterans Health Administration, Boston, MA
Don E. Detmer, M.D., American Medical Informatics Association, Bethesda, MD
Robert Enberg, M.D., Henry Ford Health System, Detroit, MI
Douglas Fridsma, M.D., Ph.D., Arizona State University, Phoenix, AZ
Emory Fry, M.D., CDR, MC, Naval Health Research Center, San Diego, CA
Mary K. Goldstein, M.D., M.Sc., VA Palo Alto Health Care System, Palo Alto, CA
Peter Haug, M.D., Intermountain Healthcare, Salt Lake City, UT
Nathan Hulse, Ph.D., Intermountain Healthcare, Salt Lake City, UT
Tonya Hongsermeier, M.D., M.B.A., Partners Healthcare, Boston, MA
Saverio Maviglia, MD, M.Sc., Partners Healthcare, Boston, MA
Craig W. Robbins, M.D., M.P.H., Kaiser Permanente-Care Management Institute , Aurora, CO
Hemant Shah, M.D., M.Surg., Henry Ford Health System, Detroit, MI

Abstract

The Morningside Initiative is a public-private activity that has evolved from an August, 2007, meeting at the Morningside Inn, in Frederick, MD, sponsored by the Telemedicine and Advanced Technology Research Center (TATRC) of the US Army Medical Research Materiel Command. Participants were subject matter experts in clinical decision support (CDS) and included representatives from the military health system, Department of Defense, Veterans Health Administration, Kaiser Permanente, Partners Healthcare System, Henry Ford Health System, Arizona State University, and the American Medical Informatics Association (AMIA). The Morningside Initiative was convened in response to the AMIA Roadmap for National Action on Clinical Decision Support and on the basis of other considerations and experiences of the participants. Its formation was the unanimous recommendation of participants at the 2007 meeting which called for creating a shared repository of executable knowledge for diverse health care organizations and practices, as well as health care system vendors. The rationale is based on the recognition that sharing of clinical knowledge needed for CDS across organizations is currently virtually non-existent, and that, given the considerable investment needed for creating, maintaining and updating authoritative knowledge, which only larger organizations have been able to undertake, this is an impediment to widespread adoption and use of CDS. The Morningside Initiative intends to develop and refine (1) an organizational framework, (2) a technical approach, and (3) CDS content acquisition and management processes that will scale with growing numbers of participants and can be expanded in scope of content and capabilities.. Intermountain Healthcare joined the initial set of participants shortly after its formation. The efforts of the Morningside Initiative are intended to serve as the basis for a series of next steps in a national agenda for CDS. It is based on the belief that sharing of knowledge can be highly effective as is the case in other competitive domains such as genomics. Participants in the Morningside Initiative believe that a coordinated effort between the private and public sectors is needed to accomplish this goal and that a small number of highly visible and respected health care organizations in the public and private sector can lead by example. Ultimately, a future collaborative knowledge sharing organization must have a sustainable long-term business model for financial support.

A. INTRODUCTION

A.1 Background

The importance of computer-based clinical decision support (CDS) is based on the many problems facing health care, and the need for proactive, point-of-care, patient-specific approaches to ensure that best practices are adopted [1]. Among the well-recognized problems are: spiraling costs [2,3], disparities of access and large numbers of uninsured [4,3], errors and unevenness of quality [5-8], slow dissemination of advances [9,10], inefficiencies and waste [11,3], fragmentation and poor communication [12,13], and a lack of patient-centered care [6].

CDS has been shown to be useful in fostering patient safety, health care quality, and cost-effectiveness of care [1]. Further, CDS fulfills the practical need of health care delivery organizations to respond effectively to programs such as pay for performance and prior authorization for medication or procedure orders. Nonetheless, successful approaches have not been broadly disseminated and adopted for a variety of reasons [1], including competitiveness, incompatibility of platforms, lack of standards, and under-utilization of electronic health records (EHRs) and computer-based provider order entry (CPOE) – major platforms in which to integrate CDS. But even for those with access to CDS, enormous, obstacles exist, including the lack of (1) sources of high quality medical knowledge in executable form, and (2) infrastructure and processes for managing and updating such knowledge and integrating it into applications. Addressing these needs is very expensive, if not prohibitive, for individual organizations, even large ones. In addition, the need for knowledge management capabilities has not yet been widely recognized except within a group of larger medical centers that have been in the vanguard of CDS adoption. Further, standards for CDS representation and integration into applications are as yet incomplete.

In 2006 the U.S. Office of the National Coordinator for Health Information Technology (ONC) and the Agency for Healthcare Research and Quality (AHRQ) commissioned a project by the American Medical Informatics Association (AMIA) and produced *The Roadmap for National Action on Clinical Decision Support,* which proposed a coordinated approach to address the above impediments [14]. The report recommended a series of activities to improve CDS development, implementation and use throughout the United States to help enable improvements in health, and the quality, safety and efficiency of healthcare delivery.

There had been little evidence to date that health care organizations, public and private, were willing to share knowledge that they believe gives them a marketplace advantage. Nevertheless this had been done in other fields, even fiercely competitive ones like genomics research, e.g., in terms of contributions to GenBank and other molecular and genetic knowledge bases. To the extent that it has occurred at all, the primary sharing of clinical knowledge in executable form has generally been limited to the activities of knowledge content providers, EHR vendors, or user groups of a particular vendor. Other ventures have been less than successful. As an example, the Arden Syntax was developed in the early 1990s, and was adopted as an ASTM standard in 1991 [15,16] and subsequently moved to Health Level Seven (HL7) in 1998; but a website for sharing of Arden Syntax Medical Logic Modules (MLMs) developed at Columbia University in the mid-1990s did not get regularly updated, and is no longer available. Arden Syntax has considerable use, but with many proprietary implementations, effectively limiting the extent to which sharing occurs. A consortium called the Institute for Medical Knowledge Implementation was formed in the early 2000s, and included health information system vendors, academic medical centers, and professional societies as members, with the goal of creating shared medical knowledge modules. The group foundered when no entity was willing to contribute content. (See: http://www.prnewswire.com/cgi-bin/stories.pl?ACCT=104&STORY=/www/story/02-11-2003/0001889281&EDATE= for brief mention, although IMKI website is no longer available.)

Further, biomedical knowledge and technology development continue to advance relentlessly, making it impossible for practitioners to keep up with current knowledge, or for organizations to keep pace by integrating the new knowledge into their own practices. Promising sources of generally available knowledge such as the Agency for Healthcare Research and Quality (AHRQ)-supported National Guideline Clearinghouse (http://www.guidelines.gov) and the Evidence-based Practice Center reports (http://www.ahrq.gov/ clinic/epc/), and the Cochrane Collaboration Library (http://www3.interscience.wiley.com/cgi-bin/mrwhome/106568753/ HOME?CRETRY=1&SRETRY=0)/ seek to establish and update authoritative collections of reports identifying best health care practices.

A current AHRQ program initiated as a part of the American Recovery and Reinvestment Act (ARRA) is the promulgation of Comparative Effectiveness Research (CER) (http://www.ahrq.gov/fund/cefarra.htm), which promises to further enhance such efforts. There are clearly many policy issues involved, such as how to assemble and organize disparate studies, whether a coordinating center should exist, what its role in guiding clinical decisions or influencing health care spending should be, and how it should be governed to ensure appropriate representation of stakeholders [17]. Assuming that a politically acceptable approach for these difficult issues is found, these knowledge resources would still not be made available in unambiguously executable (or even near-executable) form.

The technical issues and impediments involved and possible approaches to bridging the gap between such reports and recommendations and the development of ready-to-implement CDS are elaborated in the AMIA Roadmap call-to-action [14] and in the book by Greenes [1]. One attractive possibility that was highlighted in the call to action is the idea of developing a Web-accessible repository of high quality medical knowledge, in an unambiguous form that can be used as a basis for implementing CDS, and that would be available to all institutions and users. This would avoid the need for each organization to duplicate the effort of creating and maintaining such a repository. Responsibility for managing this communal repository would rest in an authoritative body that would determine knowledge to be included, formalize its representation, index it for retrieval, and keep it updated. Projects initiated over the past two years have begun to tackle this idea.

In 2008 AHRQ issued contracts for two projects, the Guidelines into Decision Support (GLIDES) project and a Clinical Decision Support Consortium (CDSC). The GLIDES project is concerned with the lifecycle of transforming guidelines from narrative form to implementation. The CDSC aims to develop cooperative approaches to share and manage CDS knowledge. The CDSC, which includes health care organizations and vendors, is using a top-down approach to develop knowledge management models, representations, and lifecycle processes, based on the internal knowledge management portal development at Partners Healthcare, and a proprietary content management platform (Documentum, EMC Corp., Hopkinton, MA).

The Morningside Initiative, described in this paper, arose at about the same time as the above efforts, in 2006-2007, as a consortium committed to developing an open, collaborative process for knowledge management in order to create a shared repository of content for CDS that would be as close to implementable form as possible. Further, a goal of this group was to follow best available models for knowledge representation and to help drive the standards development process where appropriate standards were lacking.

A.2 The Morningside Initiative

The Morningside Initiative began when a small group of prominent health care organizations came together for a working meeting at the Morningside Inn, Frederick, MD, August 28-30, 2007, under the sponsorship of the Telemedicine and Advanced Technologies Research Center (TATRC) of the US Army Medical Research and Materiel Command. The purpose was to develop a long-term plan intended to address the challenges by means of a deliberate, gradual process, initially involving selected participants for a limited set of tasks, and then expanding in scope and scale as workable approaches are developed.

Participants included representatives of the Department of Defense (DoD) Tri-Care Management/Health Affairs (TMA/HA), the Veterans' Health Administration (VHA), Partners Healthcare System (Partners), Kaiser Permanente (Kaiser), Henry Ford Health System (HFHS), Arizona State University (ASU), the AMIA, and TATRC.

The Morningside Initiative is the result of that August 2007 initial working meeting, and was the unanimous recommendation of participants. It called for a collaboration to create a repository of shared knowledge for CDS to meet the needs of and be made available to diverse healthcare providers and organizations. Subsequent to the initial meeting, Intermountain Healthcare (Intermountain) joined the other participants to form the Morningside Initiative.

A.3 Morningside Initiative Vision

The Morningside Initiative is dedicated to developing a collaborative Web-based resource that supports the sharing of evidence-based medical knowledge in executable form for clinical decision support, in order to improve the health of the community and the quality of health care,

To achieve this vision, the collaboration is a prototype of a larger future knowledge-sharing organization, aiming at developing and refining (1) an organizational framework, (2) a technical approach, and (3) content acquisition and management processes that are functional and can be scaled up to include a broader range of participants as well as an expansion of capabilities and content scope. The organizers of the Morningside Initiative concluded that the challenges of knowledge sharing (access to high quality content, reusability, tools for knowledge management, and an organizational framework to facilitate knowledge exchange) would best be addressed by bringing together its small number of highly visible and respected health care organizations in the public and private sector that could lead by example. They would develop and test a framework for knowledge sharing that could be extended to a national-level effort if successful. The rationale for this approach was based on three primary considerations:

(a) Working out the organizational and logistical issues of knowledge sharing could be best done first with a small number of participants, so that the approaches can be refined through that experience, before undertaking a large-scale initiative involving many more participants.

(b) Reluctance to share clinical knowledge by institutions could be overcome if high-profile participants have already committed to doing so and seeded the effort with a corpus of useful knowledge content.

(c) Tools and methods for knowledge management, for creating, representing, and updating the content, and for facilitating adaptation and reuse in other sites should be developed and piloted with this small group.

The general framework for the Morningside Initiative is shown in Fig. 1. Current efforts are to capture best available knowledge already implemented as CDS in the systems of participant organizations; represent it in a more sharable, less setting-dependent format; drive toward standards-based models for representation; and develop and test approaches for secondary reuse. The key test of reuse is the adoption of this knowledge in settings different from those from which the CDS had originally been implemented.

In the future, it is anticipated that external knowledge will continually arise from authoritative studies, and that a process will be established to regularly incorporate this knowledge into the shared knowledge base. This is discussed further in the section on Future Directions.

The rationale for the effort included the following potential benefits:

- In concert with the nationwide efforts to achieve widespread adoption of interoperable health IT, a collaborative approach will help attain greater proliferation of CDS than any one entity could achieve alone.

- Consistent with views at the time of formation, and in concert with the 2008 Department of Health and Human Services (DHHS) goal of "privatizing" AHIC by forming public-private entities, this effort will help to achieve the Secretary's HIT goals of an interoperable and transparent process.
- The approach will broaden the potential use and application of CDS at the point of care in order to impact health care decisions throughout the health care system.
- It will extend the reach/resources of participating entities beyond those possible when working alone.
- It will advance and foster more widespread accessibility of CDS content and interventions.
- By leveraging lessons, tactics and approaches used by others, buy-in across local, regional and national entities will be increased.
- A collective effort will address CDS topics of prime concern and importance to the national health care system in terms of cost, quality, and access to care.
- A national-level resource will facilitate adoption and more effective use of CDS within organizations that might otherwise not have the resources to pursue CDS.
- Collaboration and sharing CDS mechanisms will help leverage prior, current and ongoing work; and will help individual organizations and entities capitalize on lessons learned and approaches/methods that have been successful, thereby avoiding the need to reinvent the wheel.
- Availability of the resource will remove or lessen barriers and challenges (in terms of technical, cost, and expertise deficiencies) and thus enhance the likelihood of adoption and proliferation of CDS.
- Professional benefits will accrue to individual investigators for participation (e.g., papers, grant writing, research, and leadership opportunities).
- The collaborative mechanism will provide participating entities with a level of external validation of their CDS work regarding content quality and development approach.
- The approach will promote best practices for developing CDS interventions among and across entities and organizations.

A recognized requirement for a future collaborative knowledge sharing organization is a business model based on sustainable long-term mechanisms of support, yet to be defined, which might be expected to include a combination of organizational subsidies or membership dues, governmental and insurance industry funding, and possibly other mechanisms. For the short term, limited support has been provided through TATRC, and additional sources of support are being sought. Most of the activities described in this report have been carried out through the in-kind contributions of time and effort by the participants and their organizations.

A.4 Morningside Initiative Scope

The initiative described here *does not duplicate* the work of Evidence-based Practice Centers, the Cochrane Collaboration, Comparative Effectiveness Research, or other efforts to determine best practices and to develop guidelines based on meta-analysis and evidence-based medicine. An operational knowledge repository would, however, regularly draw upon the work of these organizations to operationalize their findings. For the near term, the Morningside Initiative takes as its starting point the "operationalized" knowledge that health care provider organizations have already determined to be useful and have implemented in various applications in their systems, usually in the form of decision rules for alerts, reminders, or medication prescribing recommendations, or as order sets. Typically these CDS modules have been drawn from guidelines, authoritative reviews or other evidence-based medicine sources, but they have been made unambiguous and computable – a process which sounds straightforward but is definitely not. Further, typically these modules are not represented in a language

that can be interpreted by other systems or applications, even within the same organization. So a major focus is to develop a common shared representation for such *knowledge*.

A subsequent phase of the Morningside Initiative is anticipated, which includes a national-scale effort to maintain and update a shared repository of executable knowledge. This would include a regular process to review and incorporate new knowledge coming from such authoritative sources as above. However, that is not the initial focus of the effort.

A.5 The importance of sharing, standards, and open systems

The ultimate purpose of this effort is to establish a continually updated and widely accessible national-level repository of authoritative knowledge in executable form. The details of the knowledge are to be fully transparent. That participation will be available to all is a guiding principle. Participation fees, if any, will not be a barrier, but may be required for self-sustaining operation.

Since standards are still immature, the goal of being able to provide knowledge in standard form is not fully attainable. Nonetheless, the Morningside Initiative intends to represent knowledge in unambiguous form by using (or developing as needed) conventions for representation that are considered by the team to be the best available, and which are fully documented. The team also works with standards development organizations to help accelerate the adoption of standards that are most urgently needed. It is expected that as this effort gains traction it may provide a major use case for such standards development, to help drive the direction of the process.

A principle of the approach is that knowledge bases are managed using open source tools and non-proprietary data formats wherever possible. This avoids licensing fees or vendor dependence, or the delays in waiting for vendors to support particular needed features. Open platforms, e.g., the J2EE framework, have demonstrated scalability and performance, and there are growing numbers of open-source software products available for various needs.

B. METHODS

The Morningside Initiative takes a **lifecycle approach** to establishing the needed organization, infrastructure, and expertise to operate such an ongoing activity for CDS sharing and reuse. The lifecycle includes:

(a) **content knowledge acquisition** (review, vetting)

(b) **knowledge representation** (formalization, standardization, and separation of core medical knowledge from contextualization/business process aspects),

(c) **knowledge management** (curation and update), and

(d) **knowledge adoption** (adaptation and deployment in operational settings).

The process is driven ultimately by the functional requirements for (d) adoption, since putting the knowledge to use is the motivation for the whole effort. Ideals are that the knowledge be of *high quality, vetted, executable, and interoperable in a clinical setting*. Each of these characteristics is important. To be regarded as high quality, it needs to have a means for viewing its evidence base, the authors and their credentials, and experience with it. To be vetted implies that there is an identifiable review process that has certified CDS quality and suitability for implementation. To be executable implies that it has been formalized to a point that eliminates ambiguity and that the data sources on which it depends are obtainable. To be interoperable implies that the definition is platform-independent. Adoption in a clinical setting implies that it can be adapted appropriately to the site's specific health information system, operations, and workflow characteristics.

The Morningside Initiative is governed by a Steering/Organization Committee overseeing two other Committees functioning as Working Groups. The committee responsibilities are as follows:

- **Steering/Organization Committee** – Initially composed of representatives of all founding organizations, the Steering Committee is expected to evolve into elected membership based on constituencies, such as professional specialty societies, health care delivery organizations, knowledge content provider entities (commercial and otherwise), and other stakeholders to be defined. This committee oversees the development and refinement of the bylaws operating procedures, conducts governance business, and oversees the evaluation and sustainability aspects of the Initiative.
- **Content Committee** – This Committee is responsible for specifying content focus priorities, acquisition, review, and rating procedures, and overseeing the content update to the repository.
- **Tools and Methods Committee** – This committee is responsible for functional requirements, tools specification, development and testing, and deployment/technical operations. It is also the primary interface for engagement with the standards development process through participation in HL7, OASIS, and other SDOs.

The Morningside Initiative is working in collaboration with the Congressionally-funded Knowledge Management Repository (KMR) project, directed by CAP Emory Fry, MD, at Naval Health Research Center, San Diego, CA, . The KMR project is aimed at developing an open-source platform for CDS for the Federal NHIN-CONNECT implementation. Thanks to this collaboration and a cooperative research and development agreement (CRADA), this hardware/software stack is installed at the ASU CARE-IT Laboratory (http://care-it.asu.edu), and is available for Morningside Initiative work. CARE-IT is collaboration between academic, government and industrial partners established to promote research into open-source, interoperable and standards-based solutions for health care information technology (HIT) and to provide an innovative infrastructure for the education of health care and technology professionals. We use this resource as the technical framework for hosting the CDS knowledge repository, delivering and ensuring interoperability of the components of this research – both the content repository, tools, and resources needed for their support – and providing a collaboration environment for participants.

The Morningside Initiative has adopted a management strategy that we believe to be truly inclusive and collaborative. The above committees, when they identify a task to be performed, designate a committee liaison person (either on the committee or approved by the committee membership) as the one responsible for overseeing that task. Together with the committees, the scope of the project, resource requirements, priority, and timeline are determined, and if approved by the committee, the resources are allocated from the technical team. The coordination of requests is overseen by a Project Management Team of the Steering/Organization Committee.

Specific activities include the following:

B.1. Establish open source, standards-based, shared repository

The **functional requirements** for delivery define needs for the CDS, the process for selecting and rating the CDS for inclusion in the repository, the tools and methods for representing it, and approaches for contextualizing it for use. Ideally, we further impose that the content and tools be **standards-based and open source**, and that the processes involved in implementing the life cycle be that of an active, **engaged**, viral open source **community** of knowledgeable developers and users. A draft set of functional requirements (see Table 1) forms a basis for our approach and is being further refined.

The initial focus in the Morningside Initiative has been on CDS content which is already implemented in existing participant sites and which has been shown to be effective. The aim is to learn from examining that content what the unique features of each implementation are, to compare knowledge aimed at similar purposes, and to forge a common representation. Knowledge content foci are determined by the organization/steering committee, and are initially primarily aimed at high priority clinical conditions, notably involving chronic disease. We have further restricted our activities thus far to examination of

diabetes rules-based knowledge, e.g., HbA1c testing, Metformin prescribing, eye and foot examination reminders, and operational definitions of chronic diseases.

Once having created a sharable representation, abstracting context-specific and site-specific aspects, the goal is to re-contextualize the content to enable it to be incorporated into another site with distinct EHR platform, organization, and workflow requirements. This analysis of content has to date been very instructive, and has identified the need to separate the core medical knowledge from the business or workflow logic and to characterize a variety of annotation meta-tags (see Table 2) that relate to things like how the CDS is triggered, how and where it interacts with applications and users during evaluation, and how the results are communicated or inserted into the workflow.

We have also shown that many apparently different rules are for the same medical purpose, once one does the above analysis. This is exemplified in Fig. 2, which is a spreadsheet comparing knowledge content gathered from Morningside Initiative participant implementations dealing with various diabetes-related rules. For example, a variety of different rules are seen all dealing with how to deliver a reminder that HgbA1c testing should occur every 6 months. It is clear that the differences in appearance are all due to the triggering, presentation, and other business logic considerations. Thus a major task of this initiative is to formalize the content acquisition process in order to understand how to represent these layers.

B.2. Develop robust content knowledge management practices and technical resources and procedures, methodologies, and representations of knowledge

The key innovation in the technical approach is to put together a variety of emerging open source capabilities and to engage the community in an active collaborative mode in its development, testing, and refinement.

Functional requirements development. The evolving set of functional requirements for the Morningside Initiative has been prepared together with those being developed for the KMR project. The latter are aimed more at the end-user delivery phase of CDS, but we believe that the requirements for the knowledge model and representations cannot be divorced from the functional requirements for the delivery of CDS, and thus we are evolving these together. As noted above, see Table 1 for draft Morningside Initiative requirements.

As mentioned above, the focus of the Morningside Initiative effort has not been to develop new knowledge. Nor has it been to render poorly specified, existing logic as explicit, computable rules. Instead, our focus has been on a model and mechanism for capturing computable, clinical knowledge in a Knowledge Repository (KR) and for making that knowledge available to systems with the infrastructure necessary to deliver CDS interventions in a way that can improve local care delivery. To accomplish this, the Morningside Initiative has focused on existing medical knowledge, already in use in the collaborating, Morningside Initiative sites. This CDS logic provides examples of content around which we build the KR and define its methodological requirements.

Using tested content as a starting point, we can address two of the key needs surrounding the transfer of CDS between sites: (1) detailed documentation of the functional requirements for each of the components found in an environment that supports CDS, and (2) a collection of use cases from which we can catalog characteristics of the clinical workflow and the clinical environments necessary for the successful delivery of CDS.

This functional requirements draft document indicates anticipated capabilities of a knowledge repository, of a knowledge authoring and maintenance system, of a service to support the sharing of this knowledge, and finally, of a typical system for executing logic imported through this service. Since these functional requirements are derived from the experience of multiple institutions, no specific language or implementation is described. The goal of the requirements document is to be complete, to the extent that a system developer might choose to implement a subset of the described functions and

have a usable system. However, this detailed level of specification is appropriate for a knowledge repository, since such a repository would be expected to manage logic from sites that have implemented differing subsets of the defined functionality.

The document referred to is in its first draft. An important activity in the next several months will be to further extend and define these CDS functional requirements. The result will be a catalog of the functions that would necessarily need to be supported in a repository for shareable medical knowledge. The functional requirements will eventually also expand in scope to include those requirements relating to new content knowledge acquisition and authoritative review/rating.

The second component of this analysis involves an aspect of CDS that clearly requires more study. Medical decision modules can be integrated into a clinical workflow in a variety of different ways. Similar logic could support alerts, observations displayed in clinical worksheets, suggested orders in a CPOE system, and a number of other potential delivery mechanisms. We believe that this attention to clinical work processes is essential for successful implementation of CDS. A knowledge repository that fails to document the approach, timing, and context of the delivery of a CDS intervention would leave a site that wishes to import these rules with documentation inadequate to do so successfully.

As we proceed in this work, we anticipate evaluating CDS logic from a number of institutions. We will treat these as "use cases" from which we will document the characteristics of the work processes that are used in successful CDS implementations. We anticipate developing or adopting templates and terminologies appropriate to capturing this information. This documentation will make the character and implications of the chosen intervention clear to any manager of a decision support environment who attempts to implement logic imported from the KR.

Tools and architectural approaches based on KMR project. The KMR project has developed an NHIN-compatible set of interoperable components that the Morningside Initiative can build upon for its work. The KMR focus has been to demonstrate that CDS material can be retrieved from a shared repository and executed within both military and civilian health information systems. It seeks to create an open source infrastructure, based on the FHA NHIN-Connect open source release, for sharing domain knowledge and executing CDS. The uniqueness of this approach is that it will not only result in an open standards platform with standardized application program interfaces (APIs) and services, but it will also contribute to the growth of a collaborative academic community, dedicated to improving healthcare. To support ongoing, iterative improvement in functional and technical capabilities, the system is being designed to collect performance and usability metrics.

Thus the KMR project is being treated by the Morningside Initiative as a key use case for delivery that has a shared design approach – that of an interoperable, standards-based, open source set of tools and resources, and an active, engaged community of developers and users.

Additional tools, methods, and processes. As part of its ongoing work, the Morningside Initiative seeks to adapt from the above, obtain externally, or build other tools and processes to construct, maintain and use CDS knowledge in a KR.

Several aspects of the KR environment deserve mention. First, the long-term goal is to conveniently host knowledge for thousands of decision modules over long time periods. This implies that there must be good tools for searching for decision modules, versioning decision modules, importing and exporting decision modules, testing decision modules, etc. In addition, the repository needs to contain more than just the decision logic. We have begun to assemble a list of metadata (see Appendix B) that we anticipate will be necessary for the management of this decision logic as well as to support queries from users of this system searching for logic to import into their own clinical information systems.

Additional components of the knowledge repository will include several forms of knowledge documentation. Users searching for CDS logic to implement in their local medical environment will wish to review experience with specific collections of knowledge before they import and implement this logic.

We anticipate providing for storage and retrieval of both unstructured and structured documentation. Pointers to appropriate articles and other documents will be provided, as would forms that allow a knowledge depositor to record measures of the success of the logic within the submitting institution. A user making a knowledge withdrawal would have access to this information to help predict the effectiveness of these CDS modules in his/her institution. We expect to use Web 2.0 rating and commenting methods for enriching the knowledge in the repository with user experience and observations.

These and other functions of the KR will be mediated by tools and processes to support:

- **Knowledge Repository**: The KR will consist of an appropriate database of medical logic and supporting information combined with a collection of services to mediate interactions with the database including knowledge import, knowledge export, multidimensional search, and other interactions with the stored medical logic and supporting information.
- **Knowledge Authoring:** A knowledge authoring and editing environment for importing of existent CDS content from collaborating institutions, inspecting and editing content, and entering and editing the metadata used to support, explain, and identify repository knowledge.
- **Knowledge Management:** As knowledge is edited, superseded, or expanded through additional cycles of importation and editing, facilities for supporting these activities and for versioning and annotating the evolving CDS logic will be needed. These will be provided along with the essential search tools to explore the stored CDS logic, its metadata, and its documentation.
- **Knowledge Testing:** A function previously used by some of the collaborating institutions is the ability to test knowledge using a collection of data (de-identified or simulated). This has proven valuable as CDS logic is edited and versioned. As a part of this work, we will explore the appropriate way to capture and manage test data within the knowledge repository and will provide tools so that regression testing of clinical logic can be accomplished.
- **Knowledge Documentation:** Tools will be provided to support and enhance the documentation of CDS knowledge stored in the knowledge repository. These will include import functions for various documents such as articles and user guides as well as forms designed to capture various characteristics of the imported logic. These characteristics would include measured response rates for alerts, descriptions of user interfaces, metadata capturing the character of the implemented workflow, etc.

The tools above are specific to the day-to-day use of the knowledge repository. However, we anticipate implementing a collection of applications and extensions to user tools to monitor usage of the knowledge repository. As a part of our efforts to provide short- and long-term information with which to evaluate the success of this KR design, we will implement a variety of audit trails and logs capturing the usage of this standards-based, open source, knowledge repository.

Examples of open source tools and platforms that we intend to explore are (a) the NHIN-Connect tools, (b) the BioCore collaboration portal being fielded at ASU, built on a .NET framework and supporting workspaces for collaboration; (c) content management environments such as Alfresco (open-access derivative of Documentum); and (d) Drools, a rules engine system.

B.3. Establish an operational public-private consortium

The organization of the Morningside Initiative will be subject to a set of procedures set forth in a Bylaws document. The Morningside Initiative is a public-private collaboration organized under a memorandum of understanding (MOU) signed by all participants. The Morningside Initiative and AMIA have agreed in principle for the Morningside Initiative to be affiliated under AMIA as an intermediate means to formalize the entity and carry out the business on behalf of its constituency. This was done as a way to maximize flexibility for long-term operation and sustainability as the entity expands to be a fully inclusive national-scale initiative. Other organizational and/or governance structures or approaches may be considered in the future.

Draft bylaws and the proposed AMIA affiliation agreement are currently being reviewed. Bylaws include language that addresses indemnification and intellectual property protection. Participants sharing content will need to be indemnified by clinical care organizations accessing and implementing this content in their respective clinical decision support systems. Further, those sharing content will be responsible for respecting their own third-party content intellectual property agreements as well as protected from having their shared artifacts sold by other third parties.

The original intent in forming the Morningside Initiative was to limit participants initially, until the organization, content, and technical approaches were sufficiently defined, before expanding. We have learned much in the past year about the nature of the collaboration process, however, and that it may be possible to actually move more quickly to a broader scale, by fully embracing an open source, open collaboration model. A key reason for this is that we have found that the interest in this activity is much broader than we had originally believed, given the general reluctance to sharing of CDS over the past decade. A large part of this is due to the focus of ONC, AMIA, and various leading health care organizations on CDS, the priorities of the Obama administration, and the new vibrancy of open source communities in production environments, notably in health care.

B.4. Drive standards evolution and adoption

A long-term goal of the process described above is to create a resource that will become increasingly used and valued as more and more of the management and documentation of health care in the U.S. is carried out electronically. We are convinced that development of and adherence to standards are central to effective implementation of EHRs and CDS. We are committed to using existing standards in this knowledge repository and, where standards are insufficient or do not exist, we anticipate applying the lessons learned in the analysis and design of the repository to promote extension of standards or to create new standards as needed.

Two kinds of standards are particularly applicable for those who wish to share CDS knowledge. The first is the language in which this knowledge is expressed. In the realm of medicine, two, overlapping, HL7 standards exist. These are the Arden Syntax for medical logic modules [16] and the GELLO expression language [18]. However, neither of these has seen widespread adoption in the medical computing community, except in the case of Arden Syntax, within vendor-specific implementations. An interesting alternative to these standards is represented by the growing use of business rules engines and other, general-purpose decision tools in some clinical environments. It appears that a repository that supports a single, computable representation of CDS logic will not be adequate.

In this context, the Morningside Initiative has begun to explore the possibility of an XML-based Interlingua as a possible tool for translating among different logic representations. Examples of such tools include the W3C RuleML (http://ruleml.org/) and a version of the Arden Syntax expressed fully in XML [19]. One of the goals of this effort will be to evaluate a subset of the existing (medical and nonmedical) standards to determine if the development of a medical *rules interchange format* is possible. The key goal of such an interchange format would be to support translations of CDS logic between languages.

In this activity we anticipate leveraging the work of others. The Morningside Initiative and KMR collaborators have regular interactions with a variety of standards organizations and expect to promote the adoption or development of a medical rules interchange format if further analysis confirms the feasibility of this approach.

The second kind of standard that is essential to the sharing of CDS logic is a mechanism to readily adapt decision logic built using data of one institution for use with data queried from the clinical database of a second institution. The central challenge when importing medical logic into a new clinical setting is to bind this logic to local data models and terminologies. This problem is known generically

as the "curly braces" problem, arguably a key reason for the limited dissemination of the Arden Syntax as a mechanism for exchanging medical knowledge.

The Morningside Initiative plans to approach this challenge through analysis of two evolving standards. One of these, the virtual medical record (vMR) offers the option of mapping a nonstandard data representation onto a simplified version of the HL7, version 3, data messaging standard. The other, a product of the Healthcare Services Specification Project (HSSP), standardizes CDS as a service. The mapping of local data to the symbolic forms used in the CDS logic occurs during the construction of the message used to invoke the service.

We believe that a key product of our future work will be examples, use cases, and functional requirements designed to support the implementation of decision logic, imported from the repository, in settings where data models and terminologies differ from those present in the originating site.

B.5. Demonstrate suitability and value for secondary reuse

We are exploring this concept in two ways. One is adaptation to local processes/workflows, and the other is adaptation to local data representations. In these activities, we seek to use standards wherever adequate. We intend to demonstrate the ability to technically interface the CDS into different platforms. One target is the DOD AHLTA system being explored through the KMR project. Another, to be done between KMR and the ASU CARE-IT lab, is the Resource and Patient Management System (RPMS) of the Indian Health Service. In both cases, the approaches to be pursued involve use of the vMR and the HSSP efforts to model decision support as a service.

B.6. Evaluate and disseminate program status and progress

Since our collaborative process is intended to be an open one, a key dissemination strategy will be through use of the web portal we establish for the Morningside Initiative. We intend to promote its use through panels and presentations at national meetings and online announcements. Through instrumentation of the web portal and inclusion of Web 2.0 assessment tools which are part of the BioCore portal design, we will track, monitor and assess content growth/update, and assess usability of tools and processes. We will also monitor cost of participation of each site and of coordination/central Morningside Initiative activities; usage logs and internal adoption by sites from repository; and governance issues/conflicts/resolution, and will publish and disseminate our results.

C. CURRENT STATUS AND FUTURE DIRECTIONS

The Morningside Initiative supports the following Critical Path Tasks identified in the AMIA Roadmap: it creates a mechanism whereby an ongoing forum for dialogue, consensus, and action by CDS stakeholders can be achieved; promotes dissemination and application of best CDS implementation practices; demonstrates the feasibility, scalability, and value of a collaborative approach to CDS by having specific, standardized tools and best practices publicly available; and provides a forum to analyze and generalize lessons learned from the development of a knowledge repository and its effects in furthering CDS.

The above processes have been going on for approximately eighteen months, and the functional requirements, metadata tags, submission templates, and a collection of diabetes rules knowledge from the participating sites have been analyzed. These serve as a basis for a current effort aimed at finalizing the selection of a software and hardware platform for subsequent build out and development of the repository and tools, and gearing up the knowledge acquisition, formalization, and management tasks.

We believe that an important future effort will be authoritative review of best available knowledge that is ready for widespread use, and to be proactive in acquiring this new knowledge, formalizing it, and integrating it into the repository to facilitate dissemination and adoption. An important development, now in its very early stages, has come out of a meeting sponsored by AHRQ and organized by HL7, called “Bridging the Chasm”, which was held in Washington, DC, April 19-21 (see:

http://www.hl7.org/btc.htm) . This meeting brought together more than 100 leaders of clinical specialty societies as well as key health care organizations to address, among other topics, the question of how we go from authoritative collections of best practice knowledge (such as AHRQ Evidence-Based Practice Centers, the Cochrane Collection, and Comparative Effectiveness Research analyses and reports, or narrative guidelines based on them) to actually changing our health care processes through broad dissemination and adoption. One question is whether any entity could serve as a trusted authority for determining which knowledge is ready for "prime time", fully recognizing how politically fraught such an activity would be. Assuming that it would nonetheless be desirable for such activity to be carried out, a segment of the discussion focused particularly on the issue of specification of such knowledge in the unambiguous, focused form of CDS rules. One outcome of the meeting was the establishment of a new effort, called the Clinical Information Interchange Collaborative (CIIC) (http://btc.hl7.org/index.php?title=Main_Page), which can be seen in a sense as a "meta-society" that will seek to develop methods for inter-society cooperation to establish a process for enabling authoritative, respected medical knowledge to be captured and made available in a form that facilitates adoption (i.e., is executable). Thus a possible future direction will be to link up with and work closely with such an activity, so as to close the loop between identified best practice and implementation.

Having such mechanisms will ultimately lead to the need for a decision in terms of the role of a national shared repository. We believe that the original content from a variety of sources, having been normalized, should be available for inspection by all users. But this is of primary benefit to secondary adopters that have needs very similar to the contributors or the wherewithal to conduct review of multiple variations and do the necessary adaptations themselves. There is a larger community of potential adopters who don't have such expertise. Also, there is continued new knowledge arising from clinical trials, EPC, Cochrane, and CER reports, and finding its way into guidelines that have not yet been reviewed for implementability or relationship to existing CDS. Such review is a labor-intensive and expensive process. Reviewing evidence from clinical trial and other sources for application to clinical care also requires unique expertise not only in the clinical content domain, but also in the evaluation of study design.

Large healthcare organizations that engage in developing their own guidelines devote substantial resources to this process. Small healthcare institutions such as individual hospitals and small group practices rarely have the resources to develop their own sets of knowledge content. Even large organizations are generally not able to produce revisions to guidelines more often than every few years. Thus this task may be an important role for a future national CDS initiative to fulfill.

C.1 Sustainability

Ultimately, a National-level initiative will have participants in both public (federal/non-federal) and private (commercial/non-commercial) sectors, and with potentially many kinds of stakeholders (providers, payers, professional societies, government agencies, standards organizations, knowledge providers, and health systems providers, to name a few). One model for sustainability would thus be long-term commitment for support by a Federal agency, much as AHRQ supports the EPCs. An alternative is to establish a means for such an initiative to obtain support from its constituency. One model is that used by membership organizations, such as AMIA and HL7. These have both institutional and individual membership categories, with benefits associated with each, but do not limit access of members to their products and services based on type of user. Rather, the fee model essentially offers "quantity discounts" based on numbers of members. Such organizations have boards of directors that govern them, and which are open to broad participation through democratic processes.

The Morningside Initiative is a first step in bringing together on a voluntary basis organizations that have taken a leadership role in developing, deploying, and demonstrating the value of CDS for health

care, to pool their expertise for the purpose of jump-starting a national knowledge sharing activity. The road ahead is long, but we have already learned that much can be gained by traveling together.

DISCLAIMER

The KMR project is supported by Award Number: W81XWH-06-2-0074, administered through the U.S. Army Medical Research Acquisition Activity, 820 Chandler Street, Fort Detrick, MD 21702-5014.

The opinions of the authors do not necessarily state or reflect those of their respective employers, including the Department of Veterans Affairs or the Department of Defense of the United States Government, and shall not be used for advertising or product endorsement purposes.

REFERENCES

1. Greenes, R. A., ed. (2007) *Clinical Decision Support: The Road Ahead.* New York: Elsevier.
2. Poisal, J. A., et al. (2007). Health Spending Projections Through 2016: Modest Changes Obscure Part D's Impact. *Health Affairs*(21 February): W242-253.
3. NCHC. (2008). Health Insurance Cost: Facts on the Cost of Health Care. From http://www.nchc.org/facts/cost.shtml.
4. CHCF. (2005). Health Care Costs 101. Retrieved 02 March, 2005, from http://www.chcf.org/.
5. Kohn, L., Corrigan, J., Donaldson, M. e. and Committee on Quality of Health Care in America, I. o. M. (1999). *To Err Is Human: Building a Safer Health System.* Washington, D.C., National Academies Press.
6. IOM (2001). *Crossing the quality chasm: a new health system for the 21st century. Institute of Medicine*. Washington D.C., National Academy Press.
7. McGlynn, E. A., Asch, S. M., Adams, J., Keesey, J., Hicks, J., DeCristofaro, A., et al. (2003). The quality of health care delivered to adults in the United States. *N Engl J Med* 348(26): 2635-2645.
8. Mangione-Smith, R., DeCristofaro, A. H., Setodji, C. M., Keesey, J., Klein, D. J., Adams, J. L., et al. (2007). The quality of ambulatory care delivered to children in the United States. *N Engl J Med* 357(15): 1515-1523.
9. Balas, E. A. and Boren, S. A. (2000). Managing clinical knowledge for health care improvement. *Yearbook of Medical Informatics*. Van Bemmel, J. and McCray, A. T. Stuttgart, Schattauer Verlagsgesellschaft mbH: 65-70.
10. Khoury, M. J., Gwinn, M., Yoon, P. W., Dowling, N., Moore, C. A. and Bradley, L. (2007). The continuum of translation research in genomic medicine: how can we accelerate the appropriate integration of human genome discoveries into health care and disease prevention? *Genet Med* 9(10): 665-674.
11. MGI. (2007). Accounting for the Cost in the United States. Retrieved January, 2007.
12. Halamka, J., Overhage, J. M., Ricciardi, L., Rishel, W., Shirky, C. and Diamond, C. (2005). Exchanging health information: local distribution, national coordination. *Health Aff (Millwood)* 24(5): 1170-1179.
13. Marchibroda, J. M. (2008). The impact of health information technology on collaborative chronic care management. *J Manag Care Pharm* 14(2 Suppl): S3-11.
14. Osheroff, J., Teich, J., Middleton, B., Steen, E., Wright, A. and Detmer, D. (2006). *A Roadmap for National Action on Clinical Decision Support.* Report. Bethesda, MD, American Medical Informatics Association.

15. Hripcsak, G., Wigertz, O.B., Kahn, MG, Clayton, P.D., and Pryor, T.A. (1993) ASTM E31.15 on health knowledge representation: the Arden Syntax. *Stud Health Technol Inform*. 6:105-12.
16. Pryor, T.A. and Hripcsak, G. (1993) The Arden syntax for medical logic modules. *Int J Clin Monit Comput*. Nov;10(4):215-24.
17. Wilensky GR. The policies and politics of creating a comparative clinical effectiveness research center. *Health Aff* (Millwood). 2009 Jun 25. [Epub ahead of print].
18. Sordo, M., Boxwala, A.A., Ogunyemi, O., and Greenes, R.A. (2004) Description and status update on GELLO: a proposed standardized object-oriented expression language for clinical decision support. *Proc MEDINFO 2004*, San Francisco, CA, IMIA: Amsterdam; 164-168
19. Kim, S., Haug, P.J., Rocha, R.A., and Choi, I. (2008) Modeling the Arden Syntax for medical decisions in XML. *Int J Med Inform*. Oct;77(10):650-6.

Tables and Figures

Table 1. Condensed functional requirements for a Knowledge Repository. Requirement categories and examples of functional requirements are included. The requirements seek to capture elements of the knowledge model, the knowledge authoring environment, the knowledge sharing environment, and the repository itself. And as-yet-unrealized goal is to specify functional requirements for a knowledge execution component of this environment.

Knowledge Delivery Model: Requirements	
Capability	**Discussion**
The system will function using Symbolic Variables The system will function using Objects (again symbolically)	A goal is to separate the logical manipulation of symbolic variables from the mapping of those symbolic variables onto (local) clinical data. Identifiers for symbolic variables are selected to be consistent with the thought processes and language of clinicians (i.e last_serum_glucose).
Time will be a Component of Variable/Object Collections.	All clinical data should retain its timestamp when rendered as a variable in decision logic. The timestamp is chosen to represent the point in time when the data value was current. (A discussion of time ranges and other, non-point time values will be postponed.)
...	...
Knowledge Repository	
Capability	**Discussion**
Allows storage (upload) of decision modules.	Hopefully through a process that "normalizes" the chunks of logic. This could be accomplished by mapping onto a standard, interchange format.
Allows retrieval (download) of decision modules in a read-only mode.	This is for download of modules to test and perhaps use in a recipient system.
Supports check out of decision modules explicitly for either editing or edit-free reviewing.	The system would allow for checkout of logic or collections of logic for editing and other management functions. This would require an "author" level authorization. When decision logic is checked out for editing by one author, it cannot be checked out for editing by other authors. When altered logic is checked back in, it would receive a new version number.
...	...

Knowledge Authoring/Maintenance	
Capability	**Discussion**
Supports views of decision modules in the repository's native (XML) markup.	The assumption is that, at least part of the decision modules will be stored in a XML-tagged data model.
Supports views of decision modules in "user friendly" text-based format.	Converters should be present that will display the decision logic and metadata in an easily read textual format
Supports views of decision modules in graphical format.	Trees or flow diagrams can show the relationship between parts of the decision logic (families of rules or modules) used to create more complex, decision output (guidelines).
• • •	• • •
Knowledge Sharing Service	
Capability	**Discussion**
Supports conversion from local knowledge models to a repository specific, medical rules interchange format (MRIF).	The goal is to find a robust "Interlingua" that will facilitate moving logical constructs from one executable form to another.
Supports conversion from the repository-specific, knowledge interchange format into forms executable in multiple knowledge execution environments.	Ideally, these knowledge execution environments would all have a local expression of the executable form in XML. This would allow most translations to be done using XSLTs.
Translators should accommodate rule models including all standard logical functions/structures.	A standard vocabulary of logical structures will need to be represented (*Add Appendix*).
• • •	• • •
Knowledge Execution Environment	
• • •	• • •

Table 2. Examples of metadata for indexing content in a knowledge repository. The collection is derived from metadata described in a number of categorization schemes for computable medical knowledge.

Metadata Title	Metadata Description	Orig. Metadata Source
Resource Title	Title of module of clinical logic.	• In Arden • In Morningside Template
File Identifier (URI)	Uniform Resource Locator(for storage); replaces filename (Arden)	• In Arden • In Morningside Template
UNID	Unique identifier for indexing through a terminology service for instance.	• In Morningside Template
Version and Branch ID	A number indicating the version. In the context of a source repository, this might capture new branches as versioning generates alternate directions in the logic.	• In Arden • In Morningside Template
Submission/Revision Dates/ Branching dates	The date associated with submission of this version.	• In Arden • In Morningside Template
Purpose	Statement of the goal of the logic (free text). May also provide tag references to a controlled taxonomy of purposes.	• In Arden • In Morningside Template
• • •	• • •	• • •

Fig. 1. General framework for the Morningside Initiative

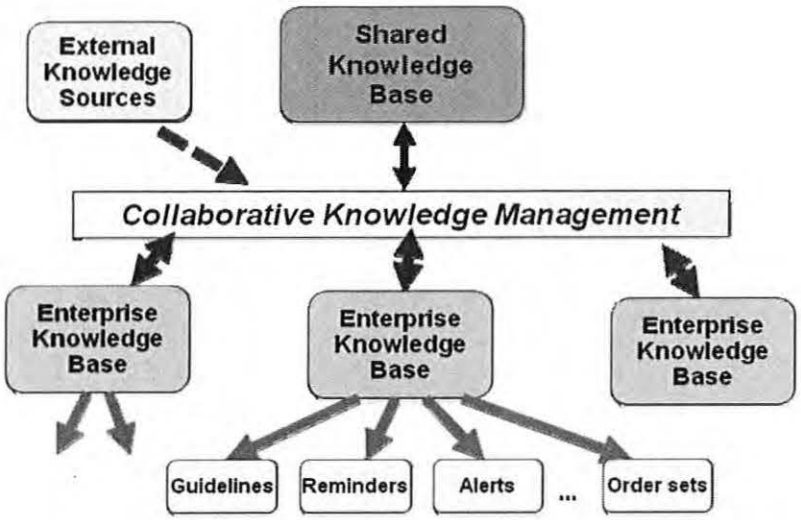


Fig. 2. Table showing example rules from Partners Healthcare, Intermountain Healthcare, Veterans Administration, and Kaiser Permanente dealing with HgbA1c assessment. Columns indicate individual rules (or disjunctive clauses of rules) by institution. The conditions potentially evaluated are enumerated in the blue section, with those included in a particular rule indicated by the value needed for satisfaction (N or Y). The actions to be performed (sending of a message or ordering of a test) on satisfaction of the conditions for a rule are indicated in the red and yellow sections of that column by the presence of a Y.

	HGBA1c_ASSESSMENT	PHS				IH				VA		KP
		Overdue	Expiring	High 1	High 2	15	16	17	18			
Conditions	Most recent HgbA1c < (or <=) 9 months old											N
	Most recent HgbA1c < (or <=) 11 months old									N	N	
	Most recent HgbA1c < (or <=) 6 months old	N	Y				N					
	Most recent HgbA1c < (or <=) 5 months old		N	Y		N						
	Most recent HgbA1c < (or <=) 3 months old			N	Y			N	N			
	Most recent HgbA1c (in the last year) > 7%			Y	Y		N	Y				
	Most recent HgbA1c (in the last year) > 8%							N	Y			
	HgbA1c documented elsewhere									N		
	HgbA1c ordered within last 7 days											N
	Patient refused HgbA1c testing within last 6 mo									N	Y	
Messages	Patient is overdue for HbA1c (rec: q 6 months)	Y										
	Missing HgbA1c data (should be done on all Patients with Diabetes)					Y						
	All Patients with Diabetes should have a HgbA1c at least every 6 months						Y					
	Diabetics need at least annual Hemoglobin A1C testing.											Y
	Hemoglobin A1C required annually for all diabetic patients. Patients with levels >7.0 should be considered for more frequent testing.									Y		
	Patient is almost due for HbA1c (rec: q 6 months)		Y									
	All Patients with Diabetes and HgbA1c between 7 and 8 should have a HgbA1c every 3 months							Y				
	All Patients with Diabetes and HgbA1c > 8 should have a HgbA1c every 3 months until under 8.0								Y			
	Last HbA1c is high, and patient is overdue for HbA1c (rec: q 3 months)			Y								
	Last HbA1c is done within 3 months, but high				Y							
	Patient refused Hemoglobin A1C testing. Ask again in 6 months.										Y	
LAB	Order A1C test today	Y	Y	Y								
	Order A1C test in 3 months			Y	Y							

Accelerating the Translation of Knowledge into Clinical Decision Support: Four National Demonstration Projects

Blackford Middleton, MD, MPH, MSc[a], Robert Greenes, MD, PhD[b], Emory Fry, MD[c], Klaus-Peter Adlassnig, PhD, MSc[d], Insook Cho, PhD, RN[e]

[a] *Clinical Informatics Research and Development, Partners HealthCare System, Harvard Medical School, Boston, MA, USA*
[b] *Department of Biomedical Informatics, Arizona State University, Arizona Biomedical Collaborative, Phoenix, AZ, USA*
[c] *Uniformed Services University of the Health Sciences, F. Edward Hébert School of Medicine, Bethesda, MD, USA*
[d] *Core Unit for Medical Statistics and Informatics, Medical University of Vienna, Austria*
[e] *Department of Nursing, Inha University, Younghyun-dong, Nam-gu, Incheon, South Korea*

Abstract and Objective

Electronic health records (EHRs), when used effectively, can improve the safety and quality of health care. For maximum benefit, however, EHRs must be paired with clinical decision support (CDS) systems to effectively influence physician behavior. Wider adoption of decision support has been held back by a variety of issues, including:

- *Difficulty translating medical knowledge and guidelines into a form that can be used by EHRs and PHRs.*
- *Technical challenges in developing a standard representation for CDS content.*
- *Absence of a central knowledge repository where human readable and executable guideline knowledge can be shared and stored.*
- *Challenges in integrating decision support into the clinical workflow and other barriers to IT adoption.*

This panel will explore challenges to fostering widespread adoption of clinical decision support at scale – across national demonstration projects from 3 countries: USA, Austria, and Korea.

Keywords: *Clinical decision support systems, personal health record, electronic health record.*

Panel description

The panel will present the work from three countries targeted at accelerating the translation of knowledge into practice via clinical decision support in healthcare information technology: the CDS Consortium, the Distributed Decision Support and Knowledge Management Project, the Morningside Initiative (USA), the CDS Architecture Project for Korea, and the MedExpert/WWW and related systems in Austria. Lead investigators from each will provide an update on progress and identification of challenges for practical implementation.

The objectives of the panel are to foster discussion and insight into handling the issues that continue to impede widespread adoption of clinical decision support, and to present opportunities to coordinate activities amongst the initiatives.

Panel organizer and participants

Blackford Middleton, MD, MPH, MSc

Corporate Director, Clinical Informatics R&D, Chairman, Center for IT Leadership, Partners HealthCare System, Harvard Medical School, Boston, MA, USA

The Clinical Decision Support Consortium (CDSC)

The goal of the CDSC is to assess, define, demonstrate, and evaluate best practices for knowledge management and clinical decision support in healthcare information technology (IT) at scale – across multiple ambulatory care settings and EHR technology platforms. To achieve this goal, the CDS Consortium is carrying out a broad array of activities over the next two to five years across member sites of the CDS Consortium:

- Carry out a survey of knowledge management practices
- Translate guidelines into actionable decision support tools
- Build a knowledge portal and repository (KPR)
- Develop CDS Web Services
- Carry out demonstrations of CDS across CDSC sites
- Build CDS performance measures and "dashboards" to measure the success of our CDS
- Evaluate our work and demonstrations, and ake recommendations to CCHIT, HITSP, the vendor community

Robert Greenes, MD, PhD

Ira A. Fulton Chair and Professor, Department of Biomedical Informatics, Arizona State University, Arizona Biomedical Collaborative, Phoenix, AZ, USA

The Morningside Initiative

The premise underlying the establishment of the Morningside Initiative is that through the initial collaboration of a small group of key, committed participants, a model can be developed and refined for sharing of CDS knowledge that addresses three key aspects of the process:

- The organizational framework under which disparate organizations can contribute their expertise and knowledge and obtain the benefits of access to shared knowledge, that can be scaled up to include a broad range of participants on a national (or international) scale
- Content acquisition, representation, and management processes that are effective and can be expanded in scope of domains and knowledge types included
- Technical capabilities to support content acquisition, editing and review, representation and annotation, incorporation into the repository, retrieval, and secondary use

Emory Fry, MD

Assistant Professor of Pediatrics and Medical Informatics, Uniformed Services University of the Health Sciences, F. Edward Hébert School of Medicine, Bethesda, MD, USA

The Distributed Decision Support and Knowledge Management (DDSS-KMR) Project
The DDSS-KMR Project seeks to develop a collaborative open-source community that collectively contributes to the legal, administrative, and technical solutions required to advance clinical decision support, patient safety, and quality improvement. It supports this primary objective by providing a run-time infrastructure for clinical decision support using the FHA NHIN-CONNECT architecture developed in the USA.

CONNECT, a fully functional service-oriented-architecture, implements a flexible, standards-based, open-source solution that enables healthcare entities to connect existing health information systems to the Nationwide Health Information Network. The CONNECT services supplement existing functionality delivering components back to the connectopensuurce.org effort in the following areas:

- The core clinical decision support infrastructure is comprised of the runtime Distributed Decision Support Services (DDSS) engine and the Knowledge Management Repository (KMR).
- Patient Services delivers a fully integrated collaboration environment having many of the functional capabilities that productivity tools such MS Outlook enable, including email, appointing, task lists, etc.
- Provider Services exposes an authoring environment (Workbench) for constructing semantically constrained clinical rules/guidelines, and provides notification services (MedAlert / Universal Inbox) for responding to CDS recommendations. Providers will have the capability to create highly personalized treatment plans for patients with common chronic conditions and for collaborating with them using intuitive and workflow appropriate ways.

Klaus-Peter Adlassnig, PhD, MSc

Professor of Medical Informatics, Head of the Section on Medical Expert and Knowledge-Based Systems, Core Unit for Medical Statistics and Informatics, Medical University of Vienna/Austria

The Austrian Providing Solutions for Clinical Decision Support" Project
The Medical University of Vienna and the Vienna General Hospital initiated and continuously support the broad introduction of decision support systems in the clinical practice of their and associated institutions. In the course of this project, the following goals have already been achieved:

- Development and implementation of a service-oriented, Arden-Syntax-based clinical decision support framework with proven transferability, easy extensibility, and broad integratebility.
- Development and implementation of the Moni/Surveillance-ICU and -NICU systems (total of 132 beds) for the fully automated early identification and continuous monitoring of hospital-acquired infections in intensive and neonatal care units (ICUs + NICUs).
- Involvement of the nationwide ELGA project coordinated by the Austrian government, aimed at establishing Austria-wide access to patient administrative and medical (at present, laboratory and radiology) data. Provider access to complement core-ELGA with clinical decision support is scheduled.

Insook Cho, PhD, RN

Associate Professor, Maternity Nursing & Nursing Informatics, Inha University, Younghyun-dong, Nam-gu, Incheon, South Korea.

CDS Architecture for Korea

The Korean government has initiated the efforts to secure the healthcare accessibility and efficiency anytime and anywhere through the nationwide healthcare information system by 2010. Clinical decision support (CDS) service was one project to design and implement standards-based interoperable CDS capabilities in the EHR context.

A CDS service architecture and several components have been developed in conjunction with the other EHR activities; defining national level's EHR architecture, developing common clinical content model and healthcare terminologies, and identifying health information exchange infrastructure. This process resulted in implementing and evaluating a prototype CDS service for hypertension management in ambulatory care settings. The process also has followed by pilot demonstration project initiatives in the three hospitals. These projects will contribute to demonstrate the feasibility of implementing the CDS architecture outside of this research team, in a systematic manner that can drive predictable improvements in health outcomes and be ready deployed in a variety of health care settings.

Statement of the panel organizer

Dr. Blackford Middleton has received agreement from all presenters to participate in the panel.

Hardened Rules for Clinical Decision Support

Technical Proposal
Solicitation #: NRC Domain 2 RFTO #4
Original

Submitted to:
Jessica Alderton
Jessica.alderton@ahrq.hhs.gov
Contracts Management/OPART
Agency for Healthcare Research and Quality
540 Gaither Road
Rockville, MD 20850

Submitted by:
Thomson Reuters (Healthcare) Inc.
5425 Hollister Avenue, Suite 140
Santa Barbara, CA 93111-2348
Tel 805-681-5828 Fax 805-681-5888

DUNS No. 03-6838092

Thomson Reuters (Healthcare) Inc. Authorized Negotiator
Tim Wibert
Director of Contracts
Tel 734-913-3105 Fax 734-913-3661
Tim.Wibert@thomsonreuters.com

Authors: Rosanna Coffey, Jerome Osheroff, Anthony Pepitone, Susan Raetzman, and Elizabeth Stranges; with Robert Greenes, Meryl Bloomrosen, and additional subcontractor organizations' input.

Table of Contents

Introduction

Thomson Reuters is pleased to respond to the National Resource Center for Health IT, Domain 2 Request for Task Order # 4. There are strong synergies between this task order and the Thomson Reuters commitment to providing professionals with "knowledge to act." We are especially well-versed in the healthcare market segment, a primary component of our business that includes empowering healthcare providers with relevant, evidence-based knowledge to drive measurable performance improvement. The team we have assembled has over three decades of pioneering experience in Clinical Decision Support (CDS) in general, and with the production and deployment of clinical guidelines in particular. We propose to support all AHRQ activities related to the production of Hardened Rules for Clinical Decision Support and do not deviate from the Task Order Statement of Work (SOW). In particular, we will perform tasks one through eight as described in this proposal within the time limits specified in the RFTO. Thomson Reuters and our subcontractors share AHRQ's passion for improving healthcare quality and reducing costs, and our combined skills make us an exceptionally effective team. This proposal outlines our approach for executing the Task Order objectives. We have suggested enhancements to selected tasks based on lessons learned from our combined experience with related activities. Our team is eager to support this important endeavor.

A. Understanding of the Project

The Task Order objective is to generate logic statements that are derived from evidence based clinical recommendations and that can be widely executed through health IT. The initial scope for such CDS rule development is to convert A and B recommendations from the USPSTF, and at least one other widely accepted, evidence based, actionable guideline into logic statements. This material will provide a "seed" collection of CDS rules that can be used readily by EHR suppliers and local implementers. These deliverables are an intermediate step toward the broader goal of ensuring that CDS rules and related tools (covering these and additional topics) optimally support medical decision making in practice and help drive widespread healthcare performance improvement.

Despite thoughtful efforts over the last three decades to translate clinical guidelines into CDS rules, there has not been widespread and successful use of such rules to improve patient care. AHRQ has played a key role in recent initiatives to define and execute on approaches for more effective CDS[1], and this task order is a next logical step in this work. Several recent developments address prior obstacles to widely useful CDS rules, and set the stage for project success. These include: growing understanding about how to translate clinical guidance into executable logic statements (e.g., generated by AHRQ's CDS Initiative and related sources[2,3,4,5,6,7,8,9]); powerful incentives for providers to leverage information technology to ensure that critical clinical interventions always happen when appropriate;[10] emerging best practices for seamlessly incorporating CDS interventions into workflow to improve care processes and outcomes;[11] and a major drive by health policymakers and others to standardize clinical information system

---

[1] See Webpage on AHRQ's CDS Initiative (http://healthit.ahrq.gov/portal/server.pt?open=512&objID=654&PageID=13665&mode=2&cached=true&wtag=wtag666); see also AHRQ's participation in developing a Roadmap for National Action on Clinical Decision Support. Osheroff, Teich, Middleton et al. (2006) - http://www.amia.org/inside/initiatives/cds

[2]Wang D, Peleg M, Tu SW, Shortliffe EH, Greenes RA. Representation of clinical practice guidelines for computer-based implementations. *Proc MEDINFO 2001*, London, UK, September, 2001;10(Pt 1):285-289.

[3] Boxwala AA, Peleg M, Tu S, Ogunyemi O, Zeng QT, Wang D, Patel VL, Greenes RA, Shortliffe EH. GLIF3: A representation format for sharable computer-interpretable clinical practice guidelines. *J Biomed Inform*. 2004 Jun; 37(3):147-61.

[4] Lobach DF, Kawamoto K, Anstrom KJ, Russell ML, Woods P, Smith D. Development, deployment, and usability of a point-of-care decision support system for chronic disease management using the recently-approved HL7 decision support service standard. *Stud Health Technol Inform*. 2007; 129(Pt 2):861-5.
standard. *Stud Health Technol Inform*. 2007; 129(Pt 2):861-5.

[5] Greenes RA, Sordo M, Zaccagnini D, Meyer M, Kuperman GJ. Design of a standards-based external rules engine for decision support in a variety of application contexts: Report of a feasibility study at Partners HealthCare System. *Proc MEDINFO 2004*, San Francisco, CA, IMIA: Amsterdam; 2004:611-615.

[6] Sordo M, Boxwala AA, Ogunyemi O, Greenes RA. Description and status update on GELLO: A proposed standardized object-oriented expression language for clinical decision support. *Proc MEDINFO 2004*, San Francisco, CA, IMIA: Amsterdam; 2004: 164-168.

[7] Haug PJ, Gardner RM, Evans RS, Rocha B, Rocha R. Hospital-Based Decision Support. In "Clinical Decision Support Systems: Theory and Practice (Second Edition)" Eta S. Berner, Editor. Springer-Verlag, 2006, Chapter 8; pages 159 to 189.

[8] Thompson DI, Classen DC, Haug PJ. EMRs in the Fourth Stage. JHIM (2007); 21(3):
49-60.

[9] Kim S, Haug PJ, Rocha RA, Choi I. Modeling the Arden Syntax for medical decisions in XML. Int J Med Inform. 2008 Oct;77(10):650-6.

[10] See, for example, "Medicare and Medicaid Health Information Technology: Title IV of the ARRA" at www.cms.hhs.gov/Recovery/11_HealthIT.asp, and the "Meaningful Use Matrix" at healthit.hhs.gov, which specifies that providers must implement a CDS rule to achieve meaningful use

[11] See, for example, Osheroff, JA, ed. Improving medication use and outcomes with CDS: a step-by-step guide. HIMSS. 2009, and other CDS implementer guidebooks in the series: www.himss.org/cdsguide.

functionality and interoperability.[12]

These favorable developments notwithstanding, there are still significant challenges associated with producing deliverables under this task order that will be widely used and useful. For example, there are still no widely adopted standards for the format or other CDS rule features that would ensure widespread adoptability. This makes a successful approach to Tasks 5, 6, and 7 – that is, assessing and synthesizing prior work, gaining feedback from key stakeholders, and producing the structured, coded logic statements – particularly critical. Likewise, the related administration, quality assurance, coordination and dissemination tasks must be handled carefully to ensure a solid foundation for scaling and enhancing these innovative work products.

Members of the proposed Thomson Reuters team have played leading roles in many of the enabling CDS developments that set the stage for successful execution of this task order, and Thomson Reuters has a long history of successful support for major AHRQ initiatives. Our overall approach will combine expert selection and utilization of the best available software tools, hands-on expertise of pioneering health informaticists, consensus building from a broad array of stakeholders, and close collaboration with AHRQ. We have secured commitment from the leading societies representing EHR vendors and clinical information system implementers to ensure that work products will be deployed broadly and provide high value. These and other details of our approach are outlined below.

B. Technical Approach and Schedule

The RFTO lays out an alternative to the multiple uncoordinated efforts currently underway by the broad community engaged in CDS development and implementation. The Task Order is aimed at creating a set of practical deliverables that will foster widespread adoption and successful use. Over time, refinement cycles and scope expansion will improve the rule set robustness. Our proposed approach to this task order is described in detail below. The following deliverable table adheres to the milestones and deliverables listed in the RFTO and provides a proposed task schedule.

---

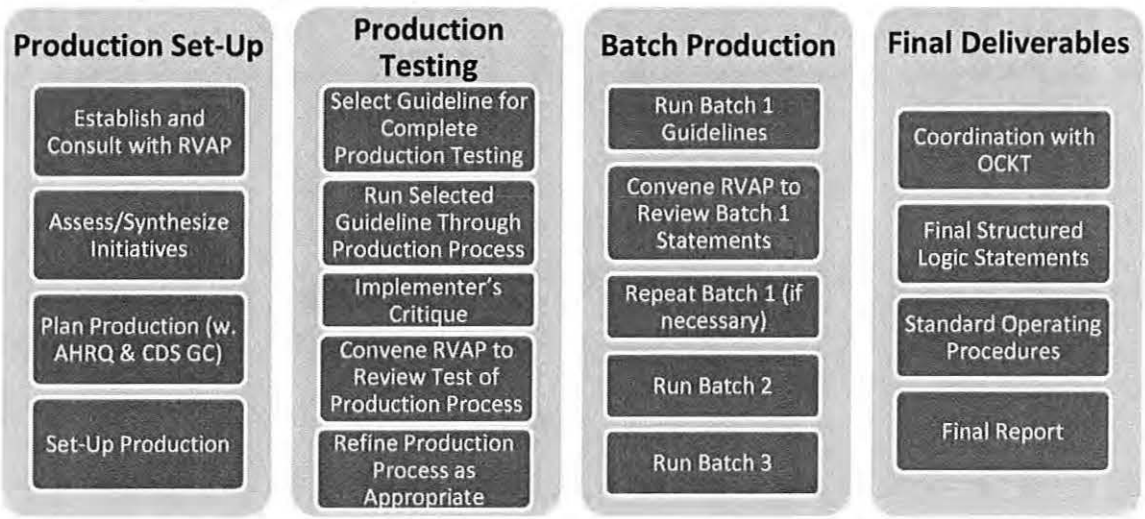
[12] For example, HITSP, ONC, HIT Policy Committee, HIT Standards Committee, CCHIT, and others. More at healthit.hhs.gov/portal/server.pt – see 'Standards and Certification.

Table 1. Proposed Project Deliverable Schedule

Deliverable #s	Task	Milestone/Deliverable Description	Due Date
#1	1.1	Kickoff Meeting	9/30/09
#2	1.2	Work Breakdown Structure	10/6/09
#3	1.3	Project Plan	10/20/09
#4-7	1.4	Quarterly Progress Reports	1/8/10, 4/9/10, 7/9/10, 9/24/10
#8-19	1.5	Monthly Meetings and Related Materials	10/12/09, 11/16/09, 12/14/09, 1/11/10, 2/16/10, 3/15/10, 4/12/10, 5/17/10, 6/14/10, 7/19/10, 8/16/10, 9/13/10
#20	2.3	Standard Operating Procedures	8/6/10
#21	4.2	508 Compliance Plan	10/21/09
#22	5.2	Summary Report of Background Assessment and Synthesis	11/20/09
#23-26	6.1	Attend CDS Collaboratory Meetings	Hypothetical dates: 11/2/09, 2/1/10, 5/3/10, 8/2/10
#27-30	6.3	Summary of Feedback from CDS Collaboratory Meetings	One week after hypothetical dates above: 11/9/09, 2/8/10, 5/7/10, 8/6/10
#31	7.1	Proposed Guidelines and Methods	11/20/09
#32	7.2	Draft Logic Statements	On a periodic basis from 3/8/10 through 6/28/10
#33	7.3	Final Logic Statements	7/23/10
#34	8.1	Draft Final Report	8/20/10
#35	8.2	Final Report	9/10/10

Our planned approach to this task features four main development stages: 1) production set-up, 2) production testing, 3) batch production, and 4) submission of final deliverables (see Figure 1). We explain each of the proposed steps in further detail in the descriptions of specific tasks that follow.

Figure 1. High Level Approach



Specific Tasks

Task 1. Administration

Thomson Reuters will manage and provide direct oversight and quality assurance for all aspects of this project by developing the project plan; leading project meetings with AHRQ and the Domain 1 Contractor; providing regular progress reports to AHRQ and the CDS Collaboratory; and overseeing work performed by our subcontractors. The numbers below reflect our subtask organization and correspond to our proposed budget.

1.1. Kickoff Call: We will coordinate with the AHRQ Task Order Officer (TOO) on the agenda for the initial planning meeting. Goals for the call will include clarifying the scope of work, deliverables, and timeline; delineating the roles and responsibilities of the Thomson Reuters team; and establishing communication protocols between AHRQ, the Domain 1 Contractor, and the project team.

1.2 - 1.3. Planning Tools and Project Plan: Thomson Reuters will develop planning tools and a project plan using Microsoft Office Project (MSOP). We will provide the TOO a timeline that includes a draft Work Breakdown Structure (WBS)—the structure for formal accountability to the government. Starting with the proposed deliverable schedule, we will lay out detailed steps within the WBS categories for our internal management purposes, evaluate proposed task durations, assess task dependencies, confirm milestones and deliverables, and revise the project plan. These data will be entered, tracked, and presented via MSOP 2003 for the duration of the project. Within three weeks of the kickoff call, the MSOP Plan will be delivered to the TOO as a single file for tracking project progress and deliverables.

1.4. Progress Reports: Thomson Reuters will develop a progress report template that lists 1) the quarterly task status of milestones and deliverables relative to the timeline; 2) items inspected for quality control by month; 3) progress on the 508 compliance requirements; 4) project expenditures relative to the budget by quarter; 5) any significant risks to project timelines and proposed solutions to mitigate the risks; 6) a summary of work planned for the next quarter; and 7) updated MSOP documents. We will submit the progress report within 10 days of the end of each quarter using the approved format.

1.5. Monthly Planning Meetings: Thomson Reuters will coordinate monthly calls with the Principal Investigator, the Project Manager, the Management Advisor (a senior administrator with extensive government project experience), key subcontractors, the AHRQ TOO and other designated Agency staff, and the Domain 1 contractor. During the meetings, we will discuss the status of active tasks, decisions needed from AHRQ, and cross-domain issues. Prior to each meeting, we will provide an agenda and handouts for AHRQ review. After each meeting, we will summarize decisions and action items from the call and distribute the information to attendees and the project team.

Task 2. Quality Control (QC) and Standard Operating Procedures (SOP)

Thomson Reuters will produce the quality assurance plan, manage the quality control inspections, and coordinate and develop a Standard Operating Procedures document.

2.1. Quality Assurance Plan: To provide AHRQ with clear and concise technical products, two types of quality control efforts are required. The first will be for technical accuracy, appropriateness, and value, requiring clinical and informatics expertise; the other for correctness and readability. Our quality control protocol will include ongoing QC that will be embedded in the development process through discussions, peer reviews, and validations between task leaders and clinicians, informatics experts, and knowledge engineers. We will also establish a process where all deliverables will be reviewed by the Principal Investigator (PI) and the QC Manager to ensure substantive accuracy. The PI and Project Manager will also provide an editorial review and final approval of all deliverables prior to submission to ensure that they are well written and conform to contractual requirements related to formatting and distribution.

2.2. Documentation of QC Inspections: The quarterly progress reports will list the inspections performed by the QC Manager by date. To provide more timely information, the inspections will be discussed in monthly meetings with AHRQ. These discussions will include the results of product reviews, problems encountered, and changes in operating procedures to address problems.

2.3. Standard Operating Procedures (SOP) Document: To permit others to replicate the work that will be performed on this project, including the processes used to set up, test, and produce structured logic—as well as the processes used to manage the project—we will assemble an SOP document. This deliverable

will include descriptions of activities and the underlying rationale. The Project Manager and task leads will be responsible for documenting activities as the project progresses.

Task 3. AHRQ OCKT Coordination

Deliverables that will be made publicly available (e.g., structured logic statements) will be cleared through the AHRQ Office of Communications and Knowledge Transfer (OCKT). Thomson Reuters will work with OCKT managers and editors to ensure that deliverables meet AHRQ public knowledge standards, Web content and 508-compliance standards, AHRQ and departmental clearance processes, press release procedures (if applicable), and OCKT timeframes. The project team will coordinate communications closely with OCKT to ensure timely releases. OCKT coordination is specified in the project timeline, although OCKT must confirm lead times needed for review and clearance.

Task 4. 508 Compliance

By law, all electronic and information technology (EIT) produced by or on behalf of a federal agency must accommodate persons with disabilities by providing an alternate means of accessing the information. Thomson Reuters has extensive experience producing Web-based deliverables, software applications, telecommunications, video, and multimedia to meet 508 compliance standards.

4.1-4.2. Draft and final 508 compliance plan: Thomson Reuters will submit a compliance plan to ensure that public deliverables adhere to the three federal regulations specified in the RFTO. The plan will specify the deliverables expected to be released through the Web and federal requirements that must be met. After receiving feedback from AHRQ on the draft plan, we will submit a final plan within two weeks. The team will use the 508 checklist to review Web content before delivering it to OCKT.

4.3. Progress on 508 compliance plan: As noted in section 1.3, quarterly progress reports will track compliance with 508 requirements.

Task 5. Background Assessment and Synthesis

We will begin this task by working with AHRQ to identify initiatives to review. Our team is currently engaged in a number of relevant ongoing projects and will bring our substantial knowledge of the field to bear on this task. We will also evaluate the guidelines to be translated and lay out a proposed grouping of

the guidelines for processing. The RFTO specifies that the USPSTF Grade A and Grade B recommendations and at least one other set of guidelines be chosen. Thomson Reuters will seek input from both AHRQ and an advisory panel, described below, to facilitate this decision making. Next we will assess advantages and disadvantages of relevant formats, tools and code sets. "Code sets" refer to the broad range of relevant taxonomies and ontologies, ranging from health standards like ICD-9, ICD-10, CPT, SNOMED and others, to the more CDS-specific multi-faceted clinical ontologies. "Formats" refer to structured collections of information, like HL7, Arden syntax, and XML variants like ArdenML. Many "tools" relevant to guideline translation have been produced in projects including GLIF, GELLO, GEM/GLIDES, the CDS Consortium, the Morningside Initiative, the KMR project, and Intermountain Healthcare and Partners Healthcare knowledge management efforts, to name only a few. Our team has played major roles in several of these efforts.

Our team will evaluate guideline translation resources and approaches by tapping into users' experiences (using listservs to communicate with the memberships of relevant organizations such as AMIA, the Association of Medical Directors of Information Systems (AMDIS), Scottsdale Institute, and HIMSS), by reviewing the contents of AHRQ's HIT portfolio, by identifying and evaluating relevant literature, and by drawing on the informatics experts on our own team and their extensive international network of contacts. We will also leverage existing tools to help facilitate project coordination and knowledge management, including Alfresco (a publicly available content management system) and Protégé (a free, open source ontology editor and knowledge-base framework).

Based on our review of these materials, input from AHRQ and the broad group of stakeholders we have identified (see Task 6), we will draft a report that documents our assessment and lays out a process for producing structured logic statements that address real world implementation challenges. After receiving feedback from AHRQ we will revise and submit our final Task 5 report.

Task 6. CDS GC Meetings

This task consists of two main components. The first is interaction with the Clinical Decision Support Government Collaboratory (CDS GC). The second, which we have added, is establishing and using a

"Rule Value Advisory Panel (RVAP)."

The CDS GC was formed in March, 2008 and is sponsored by AHRQ, ONC, and HHS. The CDS GC is an important collaboration of federal experts and stakeholders who will review deliverables and processes developed by this project. As directed by the TOO, the Thomson Reuters team will attend the CDS GC quarterly meetings in the Washington, DC area. The PI and DC-based Management Advisor will attend these in person; other required personnel will attend one meeting in person and others by phone—we plan to scheduled an in-person team production process planning and review meeting with AHRQ to coincide with a planned CDS GC meeting. Team members will present progress and describe any identified challenges related to developing hardened rules for CDS implementation. We will use this opportunity to learn from the experiences and needs the federal experts have around all phases of guideline translation—from development and dissemination to uptake and value delivery. Following CDS GC meetings, we will prepare a summary of the key insights obtained from and shared with the CDS GC.

The second effort under Task 6 is the establishment of a Rule Value Advisory Panel, or "RVAP." The RVAP will help ensure that the work of this Task Order is supported by the full range of perspectives and stakeholders required for success. These parties include guideline developers and implementers, information system providers and users, informatics experts in the full range of CDS development and implementation issues, and entities addressing performance measurement and reporting. The RVAP will augment the substantial expertise of the core team in many of the pertinent domains. It will be comprised of up to 20 additional stakeholders and experts who will interact through listserv communications and two formal teleconferences. To engage participants, we will leverage the core team's expertise and experience with key constituencies, as well as AMIA's extensive network of contacts. Several individuals and organizations have already expressed willingness to participate. AMIA will coordinate, plan for, and structure the RVAP meetings and support the development of work products and materials for the Panel's review. Dr. Ted Shortliffe will serve as the RVAP Chair and lead the two advisory panel teleconferences. The advisory work of the RVAP will be augmented by listserv communications with members of pertinent groups such as AMDIS and the AMIA Clinical Information Systems Workgroup.

Table 2 below provides examples of key stakeholder candidates for RVAP participation. We have initiated efforts to identify appropriate subject matter experts, as well as those with experience working on relevant aspects of CDS development, deployment, and value realization.

Included in the RVAP are representatives of two key constituencies: EHR vendors, represented by the HIMSS Electronic Health Record Association (EHRA), and EHR/CDS implementers represented by AMDIS (see letters of support in Appendix B). EHRA is the leading association of EHR vendors and their participation will help ensure that our final deliverables can be implemented in their members' systems. AMDIS is the leading professional organization for physicians interested in and responsible for healthcare information technology. Their involvement will engage those who lead the deployment of clinical information systems (including CDS rules) in many of the nation's health systems, thereby helping to ensure widespread rule adoption.

Table 2. Key Stakeholder Candidates for RVAP Collaboration

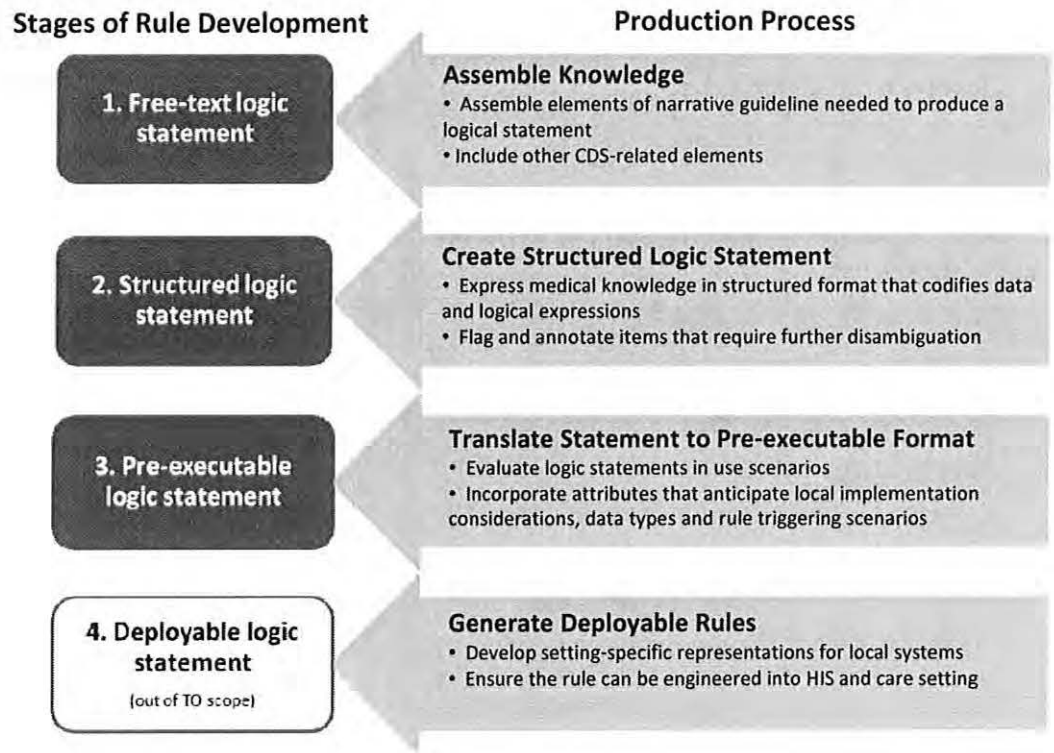
Guideline developers	USPSTF, ACIP, NIH (e.g., NHLBI), med. specialty societies
CIS vendors and implementers	EHRA, IHE, HIMSS
Informatics experts	AMIA, ACMI, AMIA Academic Forum, NLM fellowship programs, CDC Centers of Excellence
Coding/standards experts	NCHS and CMS (ICD-10); AMA (CPT); NLM (SNOMED), LOINC, CDISC, HL7, HITSP, HITSC
Performance improvement /outcome/measurement experts	NQF, NCQA, JCAHO, CMS, IHI, HEDIS, pay for performance efforts (such as Leapfrog)
Other essential stakeholders TBD	Providers (hospitals, clinics, etc.); Federal stakeholders (Armed Services); Indian Health Services, HRSA, NIH, FDA; SAMHSA, payers (AHIP, BCBSA), philanthropies (RWJF, Commonwealth etc), VA, community health centers, NGA (National Governors Association), NIST, ARP, Business Groups on Health, AFL-CIO, AHA, Cochrane, ECRI

Task 7. Create structured coded logic statements for selected guidelines

Our proposal for developing a rules repository begins with the end objective in mind. We want effective, widely deployable rules that will drive measurable performance improvement. To achieve this goal, we will create an efficient process for developing rules that can be iteratively refined, increasingly automated, and readily scaled. Once we have created such a process, we will use it to produce rules reflecting

USPSTF Grade A and Grade B recommendations, and at least one other guideline. Based on the evaluation of guidelines, formats, codes sets and tools performed in Task 5, we will propose a production plan for guideline translation, as well as an order in which to transform the guidelines. We anticipate that our plan for production will resemble that outlined in the first three stages in Figure 2 below.

Figure 2. Proposed Stages of Rule Development and Production Lifecycle



To move the rules through this production process, we will use a series of templates. Controlled vocabularies will be used for some template fields and meta-tags, and for all content data elements. In Stages 2 and 3, the reference patient data model will likely be the HL7 Clinical Statements model used in the Continuity of Care Document (CCD) specification. Our working assumption is that clinical terminology will, whenever possible, be specified in SNOMED-CT.

Because the stages shown in Figure 2 have never been fully integrated and executed in a scalable fashion, we will refine the approach as we discover how best to structure the process and create the rules in a manner that will support widespread adoption. As we begin producing the first batch of rules, we will select one recommendation to move (conceptually) through the entire development lifecycle to

understand the complexities potential implementers will confront in embedding the rule in a production system. While we are not proposing to translate guidelines through Stage 4, that is, into a format directly suitable for implementation in a given setting and clinical information system, our production plan will move one guideline conceptually into Stage 4 to help ensure that the Stage 3 rules we produce can be readily deployed into production systems. Once the selected guideline has been moved through Stage 3, a CDS implementer (Johns Hopkins) will review the final rule in terms of its ability to be integrated into their information systems. They will evaluate the rule's triggering process, its ability to be integrated into practice workflow, and the usefulness of the representation for direct interpretation or conversion into a form that can be directly interpreted or executed. AMDIS members will conduct similar, though less formal, assessments. This evaluation will constitute the "conceptual" Stage 4 implementation.

After the implementers' critique, we will hold the first teleconference with the RVAP to review the results and refine the production process. This test and review approach will influence the format and content of the final deliverable to ensure that it will achieve the goals of widespread deployment and usefulness. In addition, regular interactions with the CDS GC will provide federal perspective on how hardened rules can be developed and deployed in HIT systems to align care with strong clinical evidence.

The production of the logic statements, which will be available for uptake by the implementer and HIT vendor communities, will occur in batches to allow for further refinement of the process, phased production, and review of the rules by AHRQ. We will propose priorities for rule production, grouping guidelines into batches based on their suitability for full implementation in clinical systems (e.g., Group 1 might include guidelines for which rule triggering and evaluation data can be readily obtained in existing clinical systems and for which workflows are straightforward. When production of the first guideline batch has been completed, we will reconvene the RVAP to review the process and the results, and then make any necessary changes. As we gain experience, we will encode additional rules that raise greater translation and implementation challenges. An outline of each stage of the production pipeline follows; proposed details would be enhanced based on Task 5 results.

Stage 1: Assemble Knowledge. Clinical experts will assemble the actionable elements of the narrative

guideline that are needed to produce a free text logic statement and any necessary annotation. The resulting logic statement will outline the recommendation in a manner appropriate for eventual execution as a CDS intervention. That is, it will lay out all of the components within the recommendation that are pertinent to creating an 'if...then...else..." statement that can be executed within a clinical information system. These include descriptions of what should be done, to whom it should be done, when it should be done, how often it should be done, and any reasons it should not be done. The quantities and types of pertinent elements may differ with each type of guideline or recommendation (e.g., those for screening tests for early detection may vary from those for drug treatment). At this stage we will simply collect all these pertinent characteristics and organize them in a template for further analysis.

Stage 2: Create Structured Logic Statements. In Stage 2, the free text statement will be expressed in a structured format that organizes the medical logic and data contained in the statement. We will also tag and structure other components and apply meta-tags to categorize each element. For example, elements pertaining to eligibility criteria, recommended actions, or care setting will be identified as such. During this stage, any ambiguities in the free-text statement that need to be specified before implementation will be annotated in the rule markup. The meta-tags will be drawn from the GEM[13] schema for narrative markup, and others we have identified as valuable for characterizing workflow and clinical context attributes. XML authoring tools will support meta-tag management. Our team has particular experience in developing XML-oriented forms with Altova Corp's XMLSpy and StyleVision tools, and we plan to use this tool suite for forms design and meta-tagging. We are also tracking development of open source CDS authoring/editing tools in projects with which our team members are involved, including the Morningside Initiative and the KMR project, and will leverage those as appropriate.

Stage 3: Produce Formal Logic Statements. During Stage 3, the structured logical statement will be translated into a pre-executable format using ArdenML,[14] a meta-level formalism that can subsequently

---

[13] Shiffman R, Karras B, Agrawal A, Chen R, Marenco L, Nath S. GEM: A proposal for a more comprehensive guideline document model using XML. *J Am Med Inform Assoc.* 2000; 7:488–498.

[14] Kim S, Haug PJ, Rocha RA, Choi I. Modeling the Arden Syntax for medical decisions in XML. *Int J Med Inform.* 2008 Oct; 77(10):650-6.

generate Arden Syntax MLMs or other output formats. At this point, local implementation considerations will be taken into account, as will rule triggering scenarios. The data types and corresponding codes that will be needed to gather data to trigger rules and evaluate logic—and to enable rule actions via appropriate channels—will be identified. Methods for triggering the rule also will be formulated. Because of the various potential rule triggers—such as actions based on internal clocks, on patient encounters, and on automated review of patient records—Stage 3 output might present the potential user (a rule implementer) the opportunity to pick the alternative best suited to the local environment.

Stage 4: Conceptually Implement in Specific Setting(s). The final stage of the first-pass rule lifecycle is beyond the scope of this Task Order. Nonetheless, because anticipating local implementation is critical to ensuring optimal value from project deliverables, we include it in the lifecycle diagram, and address it by conceptually developing and vetting output at this stage, as outlined above. Fully addressing this stage requires engineering the rule into a specific clinical information system and care setting, a task which would involve adapting rule parameters to local clinical policies, and then either encoding the rule in the host rule-evaluation language or embedding it in a service-oriented architecture (SOA)-based module. By using Arden ML in Stage 3, translation into a SOA-based module can be semi-automated.

Task 8. Final Report

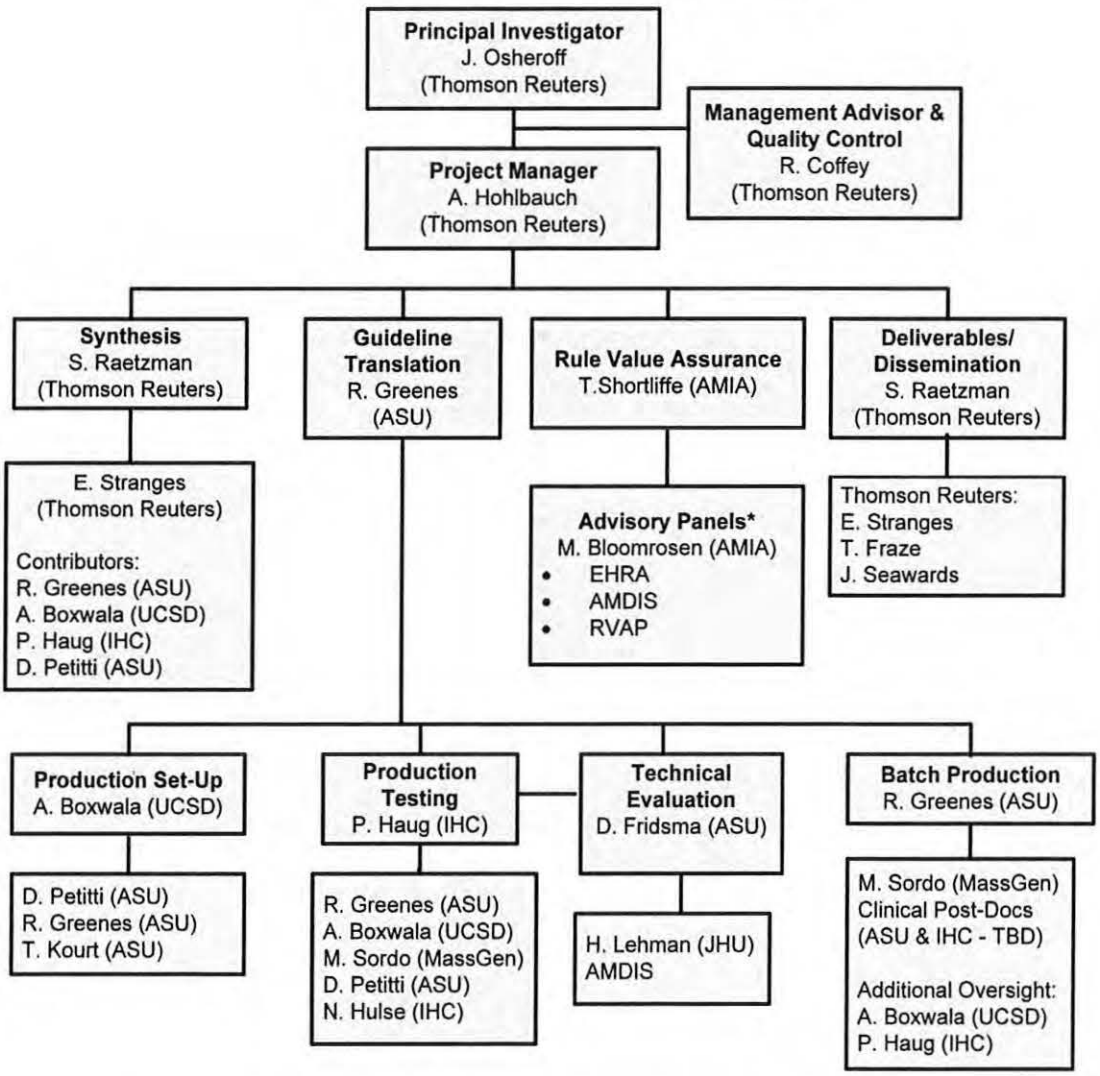
8.1. Draft and Final Report: Thomson Reuters will develop a final project report that includes 1) project purpose and background, 2) intended audiences, 3) methods and processes used to accomplish the project, 4) a summary of key deliverables, 5) advice for other guideline translation efforts, and 6) other lessons learned from the rule development process. Appendices will include templates and checklists useful for other guideline translation projects. The report will be designed for Web dissemination with a PDF version for print distribution. It will include an executive summary, a hyperlinked table of contents, main text, and appendices. The plan for the final report will be specified in the Project Plan of Task 1.

C. Personnel

The strength of the Thomson Reuters team lies in our diverse perspectives and deep expertise in clinical decision support, as well as in our shared sense of an effective approach to accomplishing the

requirements of this Task Order. In addition to the expertise Thomson Reuters offers, our team includes subcontractors from AMIA, Arizona State University (ASU), Intermountain Healthcare (IHC), Johns Hopkins University (JHU), and the University of California at San Diego (UCSD). Leaders of the project are specified in the Organizational Chart below (Exhibit 1) and their education and experience is individually described in the CVs provided in Appendix A.

Exhibit 1. Organizational Chart



* Advisory Panels: EHRA: Electronic Health Record Association, AMDIS: Association of Medical Directors of Information Systems, RVAP: Rule Value Advisory Panel

The proposed project team includes:

- **Thomson Reuters**, providing leadership on leveraging CDS to improve care process and outcomes and on overall project design (by Jerome Osheroff, MD, Principal Investigator); management direction to staff and technical contributors (by Andriana Hohlbauch, MPH); senior-level quality control (by Rosanna Coffey, PhD in Economics); and strong task leadership for synthesis, deliverables, and dissemination (by Susan Raetzman, MSPH).
- **American Medical Informatics Association,** providing connectivity to nationally and internationally renowned expertise in biomedical and health informatics; leadership for the Rule Value Assurance function, including chairmanship of the proposed RVAP and collaboration on project design (by Ted Shortliffe, MD, CEO); and management of the RVAP and liaison with EHR vendors and implementers through the **HIMSS Electronic Health Records Association** (EHRA) and the **AMDIS** (by Meryl Bloomrosen).
- **Experts** that will lead the Guideline Translation task and its subtasks. These are clinicians and PhDs who understand the clinical decision-making process firsthand and who are professionally recognized for their pioneering and foundational accomplishments in designing and operating CDS systems, particularly in terms of the highly technical and specialized area of rule specification, translation, and implementation. The experts include:
  - **Robert Greenes, MD, PhD,** as the proposed Task Lead for **Guideline Translation** overall and as Subtask Lead for **Batch Production,** has long experience and expertise in clinical decision making, knowledge representation, knowledge management, and in individualized context-specific decision support. In addition, **Margarita Sordo, MSc, PhD**, who has over 10 years of experience applying artificial intelligence and knowledge elicitation and formalization techniques in various areas of healthcare, will be instrumental in supporting the batch production function.
  - **Aziz Boxwala, MD, PhD,** as Subtask Lead for **Production Set Up**, is a seasoned developer and translator of clinical guidelines who is currently working with AHRQ on related projects. Also contributing to this function will be **Diana Petitti, MD, MPH** Vice-Chair of the USPSTF.

- **Peter Haug, MD,** as Subtask Lead for **Production Testing**, will bring to this project his practical experience in developing components of medical information systems and innovative tools for implementing decision support in active clinical settings such as Intermountain Healthcare.
- **Douglas Fridsma, MD, PhD**, as Subtask Lead for **Technical Evaluation,** will bring to this project his technical expertise in semantic interoperability and systems architectures and his collaborative experiences in testing CDS implementation.

D. Management Plan, Capability, and Past Performance

To succeed, this project requires collaboration from specialized experts in the many facets of guideline translation and from many stakeholders in the end product, making the management plan critical. This section addresses key management plan components and includes information on our corporate experience, selection of team members, and our management tools and systems.

Management Plan. The required expertise in guideline translation and execution demands that our project team have broad and deep expertise in CDS. In addition to proposing to subcontract with five organizations and one consultant, we have identified organizations willing to provide in-kind support and other experts who are interested in participating in the RVAP. To manage such a large and diverse team of stakeholders, and to ensure that project deliverables and objectives meet AHRQ's intentions, we will establish management systems that include: clear organizational structure directing lines of authority and avenues of communication, a staffing plan by task, a timeline with detailed deliverable and work review schedules, structured budget and accounting processes with customized reporting capability, quality control processes (described in section B), and standard progress reports and status meetings with AHRQ and with our subcontractors.

Capabilities and Team Selection. Thomson Reuters has assembled a strong team of experienced professionals for this task order. Our proposed PI has led highly successful and influential collaborative efforts around CDS research and development, implementation best practices, and policy. The Project Manager has a track record of effective day-to-day management of large, high-visibility initiatives such as CMS's Medical Home demonstration, and the Quality Control manager has a career-long reputation as a

strong government contracts liaison. Other members of our team include leading stakeholders with extensive expertise in clinical informatics, excellence in care delivery, EHR systems, and technical rule translation. More detailed capabilities are available in the CVs provided in Appendix A.

Table 3 below provides staff allocations by task and the percent availability for all team members.

Table 3. Staff Percent Dedicated Time to Project

RFTO #4 Proposal under AHRQ HIT IDIQ #HHSA 290200900022I – "Hardened Rules for Clinical Decision Support"	Total	% Proposed	% Availability	Task 1: Administration	Task 2: Quality Control & Std Opg Procedures (SOP)	Task 3: OCKT Coordination	Task 4: 508 Compliance Plan	Ta Syn
Year 1 - Hours by Task								
Coffey, R.	54	3%	15%	2	20	-	-	
Hertel, K.	64	3%	50%	26	8	4	4	
Hohlbauch, A.	232	12%	30%	168	30	4	4	
Mummert, A.	24	1%	20%	-	-	-	24	
Osheroff, J.	192	10%	15%	26	26	-	-	
Raetzman, S.	152	8%	25%	56	16	-	-	
Seawards, J.	40	2%	10%	-	-	-	-	
Stranges, E.	256	13%	30%	26	24	30	-	
Consultant - Sorda, M.	225	12%	20%	-	-	-	-	
Subcontractor - AMIA support	391	20%	25%	85	18	24	-	
Subcontractor -Arizona State University	614	32%	35%	68	12	-	-	
Subcontractor - Intermountain Healthcare Services, Inc.	852	44%	75%	4	-	-	-	
Subcontractor - Johns Hopkins University	56	3%	10%	-	-	-	-	
Subcontractor - University of California San Diego	154	8%	10%	-	-	-	-	
	3,306			**461**	**154**	**62**	**32**	

Past Performance. As outlined above, the team has led many of the enabling initiatives related to CDS rule development and dissemination. Corporate qualifications of Thomson Reuters, Johns Hopkins University, and AMIA regarding the creation of successful collaborative relationships and demonstrably valuable CDS resources are outlined in the original IDIQ proposal. Following are key examples of relevant team member experiences related to translating clinical recommendations into system-integrated formats and developing clinical guidelines.

- An inventory study at Partners Healthcare (Greenes, Boxwala) that involved examining all rules-based knowledge in the various IT applications, their different representations, editing approaches, and delivery modes, and synthesizing these results to propose a rules engine approach (Greenes, Sordo) to CDS delivery. The model identified a small set of predicate classes that comprised all of the

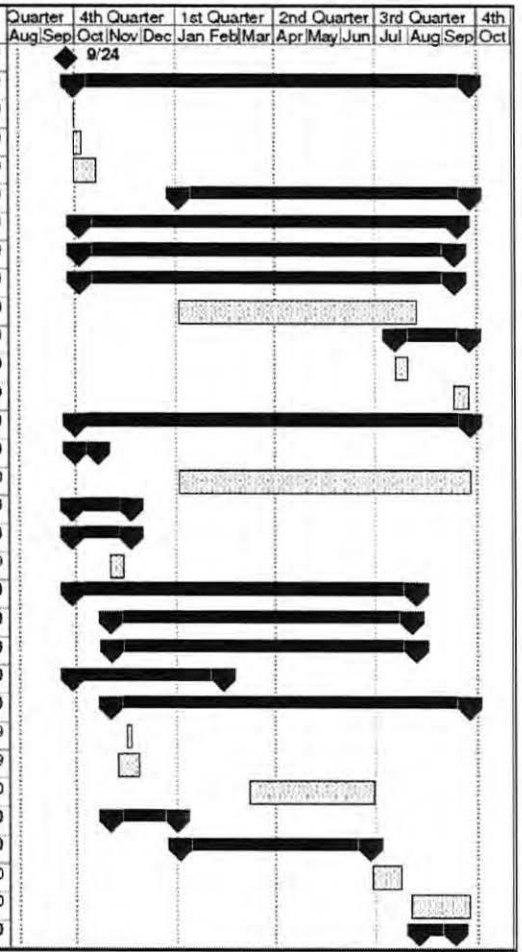
hundreds of rules, a modest set of data object type references, and a limited set of action types that could lend themselves to more structured representation and template- or wizard-based authoring.

- Creation of specification for GELLO expression language (Greenes, Sordo, Boxwala), work on GLIF (Greenes, Boxwala), and a hierarchical intention-based refinement of the GLIF guideline model (Boxwala, Greenes). Establish GELLO as a standard (Greenes, co-chair of HL7 CDS Technical Committee) and adoption of the Virtual Medical Record (VMR) model as a proposed standard.
- Major contributions to the development of the BRIDG model for protocol-driven medical research (Fridsma), supported by CDISC and HL7. Development of an XML-based model for interchangeable CDS based on the Arden Syntax known as Arden ML (Haug), which has a higher degree of semantic interoperability. Promotion of Arden ML consideration in HL7 as a next-generation standard.
- Participation in the Morningside Initiative (Greenes, Fridsma, Haug), a consortium of institutions developing approaches to knowledge sharing for clinical decision support, and in the KMR project of the Department of Defense (Fridsma). The KMR project involves developing a platform for open source authoring/editing and deploying CDS, initially focused on the AHLTA environment. The ASU Department of Biomedical Informatics also runs the Clinical Application, Research, and Education Interoperability Testbed (CARE-IT) Consortium (Fridsma) focusing on developing and testing interoperable health care information technology resources.

Project Timing. The Gantt chart below provides an overview of planned project tasks and deliverables by calendar month.

Exhibit 2. Project Timeline and High level Deliverables

ID	Task Name	Duration	Start	Finish
1	EFFECTIVE DATE OF CONTRACT (estimated)	0 days	Thu 9/24/09	Thu 9/24/10
2	**MANAGEMENT (Task 1)**	**258 days**	**Wed 9/30/09**	**Fri 9/24/10**
3	Kickoff Meeting (1.1)	1 day	Wed 9/30/09	Wed 9/30/09
4	Work Breakdown Structure (1.2)	5 days	Wed 9/30/09	Tue 10/6/09
5	Project Plan (1.3)	15 days	Wed 9/30/09	Tue 10/20/09
6	**Quarterly Progress Reports (1.4)**	**190 days**	Fri 1/8/10	**Fri 9/24/10**
11	**Monthly Calls and Materials (1.5)**	**246 days**	Mon10/12/09	**Mon 9/13/10**
24	**QUALITY CONTROL AND SOP (Task 2)**	**245 days**	**Mon 10/5/09**	**Fri 9/10/10**
25	**Ongoing Quality Control and Inspections**	**245 days**	**Mon 10/5/09**	**Fri 9/10/10**
52	SOP Documentation (2.3)	155 days	Mon 1/4/10	Fri 8/6/10
53	**OCKT COORDINATION (Task 3)**	**49 days**	**Mon 7/19/10**	**Thu 9/23/10**
54	Review/clearance for Final Logic Statements	10 days	Mon 7/19/10	Fri 7/30/10
55	Review/clearance for Final Report	10 days	Fri 9/10/10	Thu 9/23/10
56	**508 COMPLIANCE (Task 4)**	**257 days**	**Thu 10/1/09**	**Fri 9/24/10**
57	**Final 508 Compliance Plan (4.2)**	**15 days**	**Thu 10/1/09**	**Wed 10/21/09**
60	Quarterly Progress Reports	190 days	Mon 1/4/10	Fri 9/24/10
64	**SYNTHESIS (Task 5)**	**40 days**	**Mon 9/28/09**	**Fri 11/20/09**
65	**Background Assessment and Synthesis (5.2)**	**40 days**	**Mon 9/28/09**	**Fri 11/20/09**
70	Plan Production Process with AHQR/CDS-CG	10 days	Mon 11/2/09	Fri 11/13/09
72	**ADVISORY MEETINGS/CALLS (Task 6)**	**225 days**	**Mon 9/28/09**	**Fri 8/6/10**
73	**CDS CG Meetings (6.1)**	**196 days**	**Mon 11/2/09**	**Mon 8/2/10**
78	**Feedback Summary on CDS CG Meetings (6.3)**	**199 days**	**Mon 11/9/09**	**Fri 8/6/10**
83	**Establish and Consult RVAP**	**100 days**	**Mon 9/28/09**	**Fri 2/12/10**
87	**GUIDELINE TRANSLATION (Task 7)**	**234 days**	**Mon 11/2/09**	**Thu 9/23/10**
88	Propose Guidelines and Methods (7.1)	5 days	Mon 11/16/09	Fri 11/20/09
89	Set Up Production	15 days	Mon 11/9/09	Fri 11/27/09
90	Draft Logic Statements (7.2)	81 days	Mon 3/8/10	Mon 6/28/10
91	**Production Testing**	**45 days**	**Mon 11/2/09**	**Fri 1/1/10**
96	**Batch Production**	**125 days**	**Mon 1/4/10**	**Fri 6/25/10**
102	Final Logic Statements (7.3)	20 days	Mon 6/28/10	Fri 7/23/10
103	Web Tool/Dissemination	39 days	Mon 8/2/10	Thu 9/23/10
104	**REPORT (Task 8)**	**25 days**	**Mon 8/9/10**	**Fri 9/24/10**



Knowledge Management Repository
&
Clinical Decision Support Services

April 13, 2009

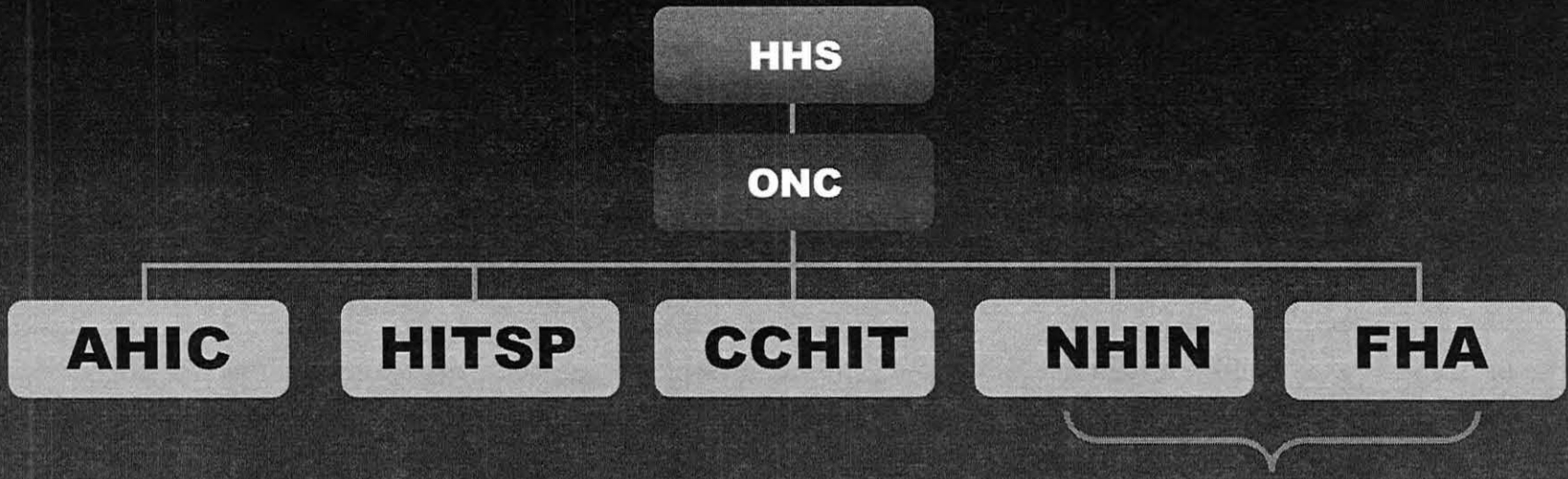
emory.fry@med.navy.mil

Objectives

- Explain how NHIN-Connect can provide a framework for CDS
- Describe KMR objectives, approach, and distinguish it from the Morningside Initiative
- Present proposal for CDS Collaboratory

emory.fry@med.navy.mil

Office of the National Coordinator



Nationwide Health Information Network

emory.fry@med.navy.mil

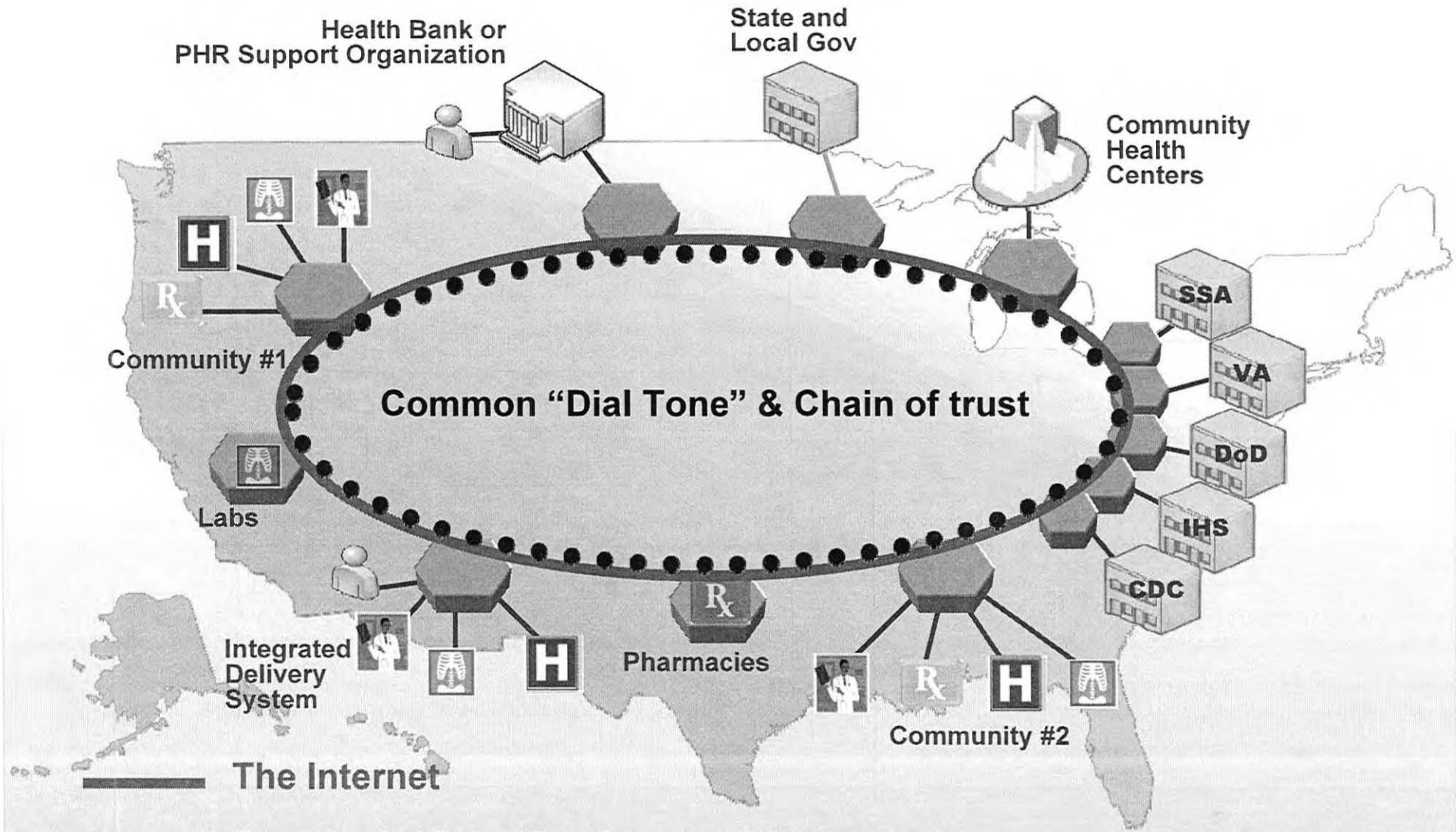
NHIN Mission

Mission

To achieve better quality, value, and affordability of health and wellness services by establishing the Nationwide Health Information Network as the common, secure, nationwide, interoperable network for exchanging health information, and provide this infrastructure with low adoption barriers.

emory.fry@med.navy.mil

The Nationwide Health Information Network



CONNECT: Tools for Information Exchange

Decoupled standards-based common infrastructure

The Gateway, which implements the core services defined by the NHIN

Enterprise Service Components, which provide robust tools for indexing patient identities, maintaining patient health documents, implementing business rules for authorizing the release of medical information and more

The Software Development Kit (SDK), which enables developers to customize the Gateway and add or replace enterprise service components

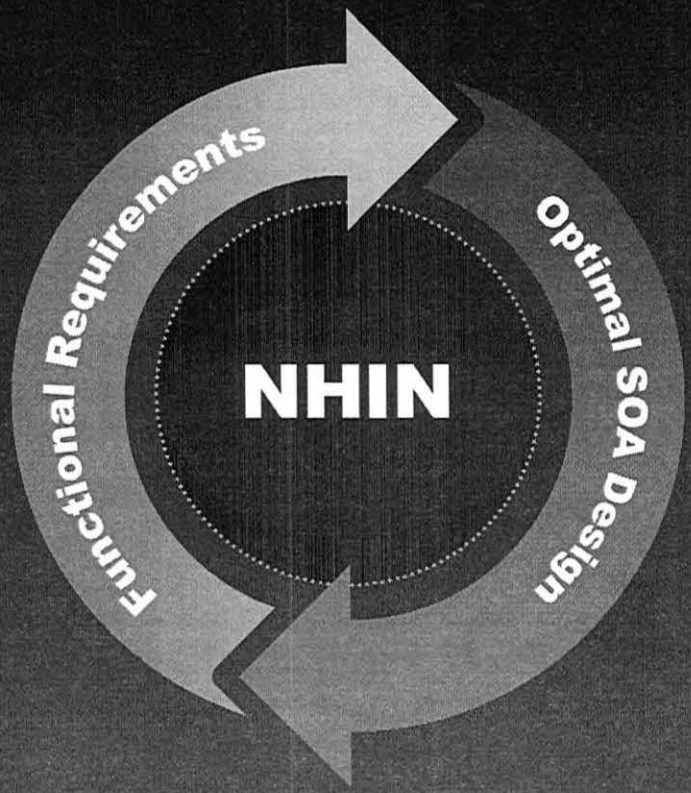
emory.fry@med.navy.mil

CONNECT Community Portal

- Launched April 5th at HIMSS to provide a community for the purpose of collaboration and innovation
- www.CONNECTopensource.org
- Host location for CONNECT events and current open source application

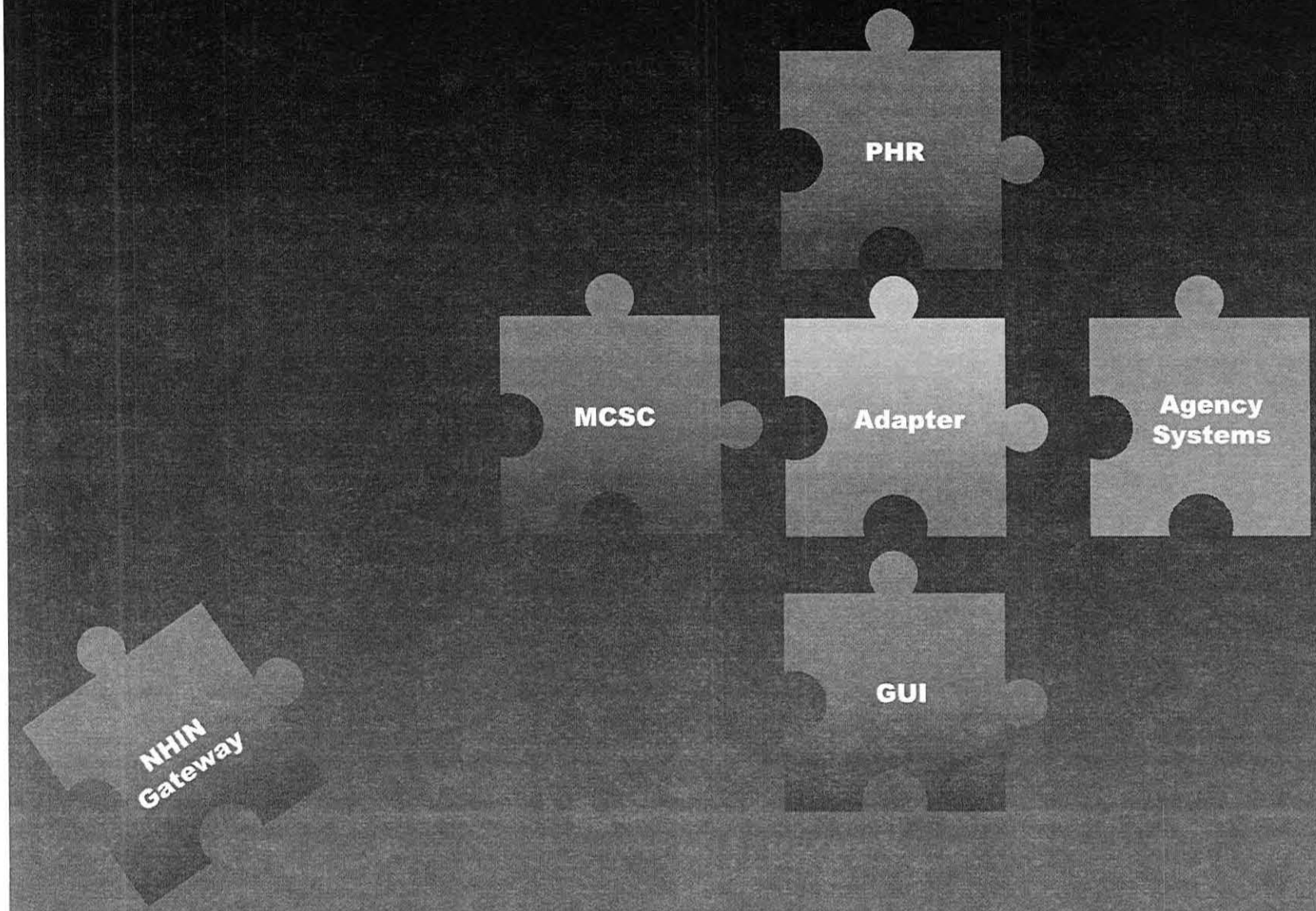
emory.fry@med.navy.mil

NHIN Reconsidered



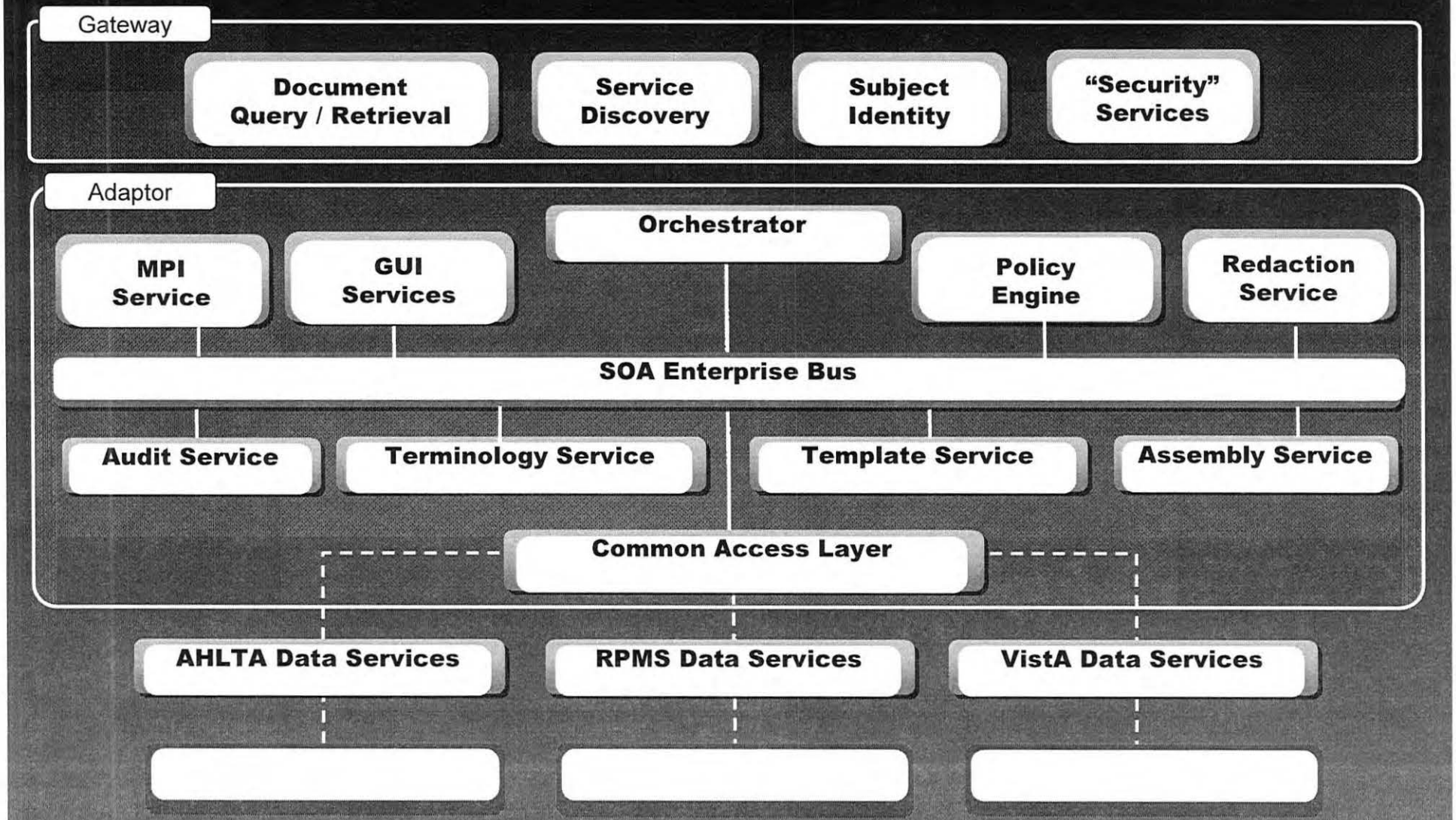
emory.fry@med.navy.mil

Federal SOA Bus For Healthcare?



emory.fry@med.navy.mil

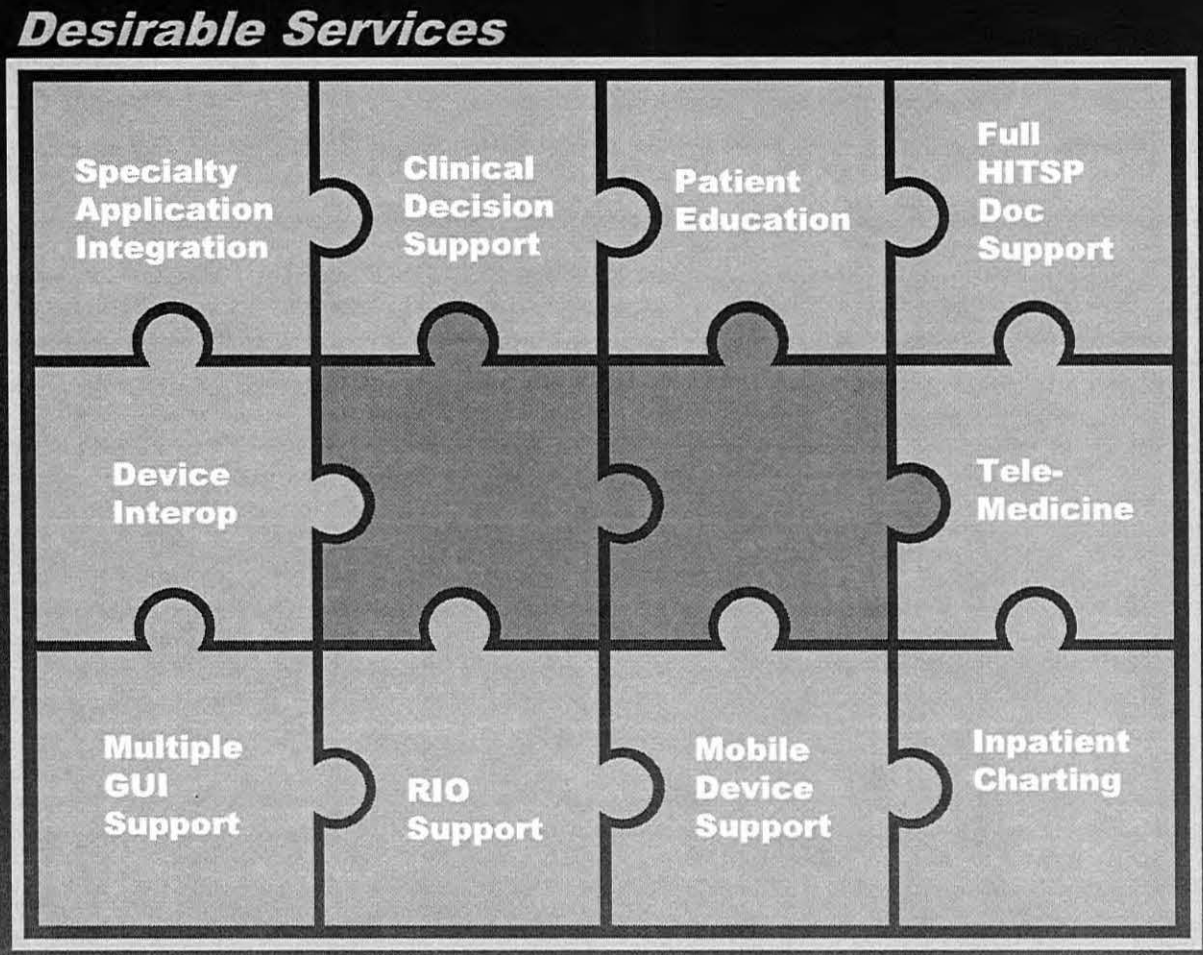
“Federal” Adaptor Concept



emory.fry@med.navy.mil

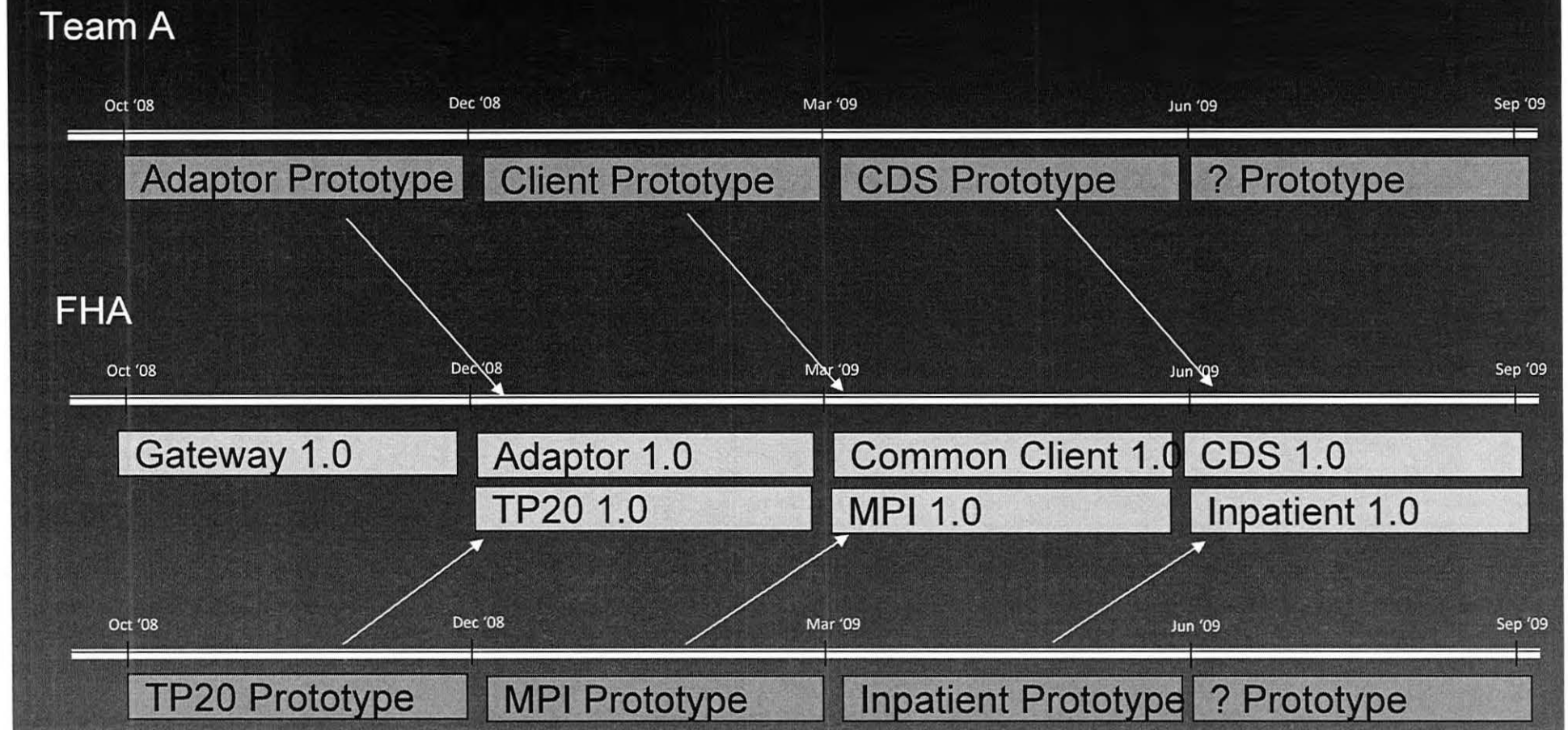
Future SOA Components

Future SOA services can be developed to support non-NHIN use cases. The components simply plug into the bus to rapidly provide new functionality..



emory.fry@med.navy.mil

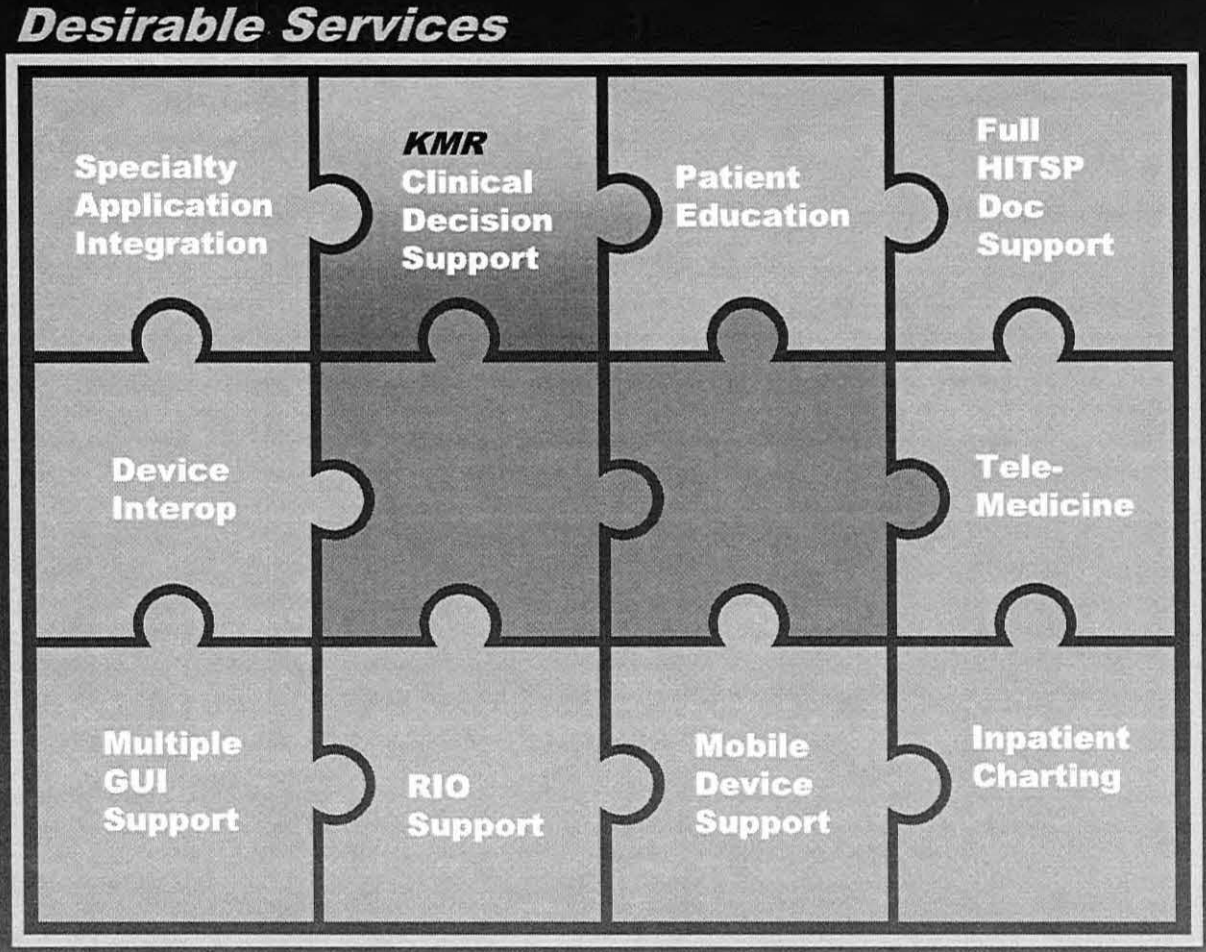
Development Coordination



emory.fry@med.navy.mil

Future SOA Components

Future SOA services can be developed to support non-NHIN use cases. The components simply plug into the bus to rapidly provide new functionality..



emory.fry@med.navy.mil

Knowledge Management Repository

emory.fry@med.navy.mil

KMR History

- 2007 – originally contracted as "Clinician Centered Evaluation of the Usability of AHLTA and Automated Clinical Practice Guidelines at TAMC"
- 2007 - TATRC sponsored the first Morningside CDS Meeting
  - defined the requirement of a knowledge management repository / system
- 2008 - KMR contract mod to reflect MS priority

emory.fry@med.navy.mil

Reshaping KMR

- 2009 - legal and contractual concerns significantly impacted project execution
  - Change in Principle Investigator
  - Adds the DFARS 252.227-7020 “Rights in Special Work” clause
- KMR objectives restated for better clarity, military relevance and for technical / contractual execution

emory.fry@med.navy.mil

AIM #1

- Fully document KMR and Clinical Decision Support Engine functional requirements, technical design, and interface controls using MHS standard documentation methodologies
- Contract Morningside subject matter experts to contribute to requirements and system design review

emory.fry@med.navy.mil

AIM #2

- Develop the technical infrastructure and tools to support domain knowledge development, management, dissemination, and run-time execution of computable clinical decision support algorithms and automated clinical practice guidelines as a service for the NHIN bus

emory.fry@med.navy.mil

AIM #3

- Develop computable clinical guidelines for TBI, PTSD and Diabetes as domains with high military importance.

emory.fry@med.navy.mil

AIM #4

- Demonstrate execution of these computable clinical guidelines using the MHS AHLTA client and data repository and the prototype KMR and Clinical Decision Support Engine.

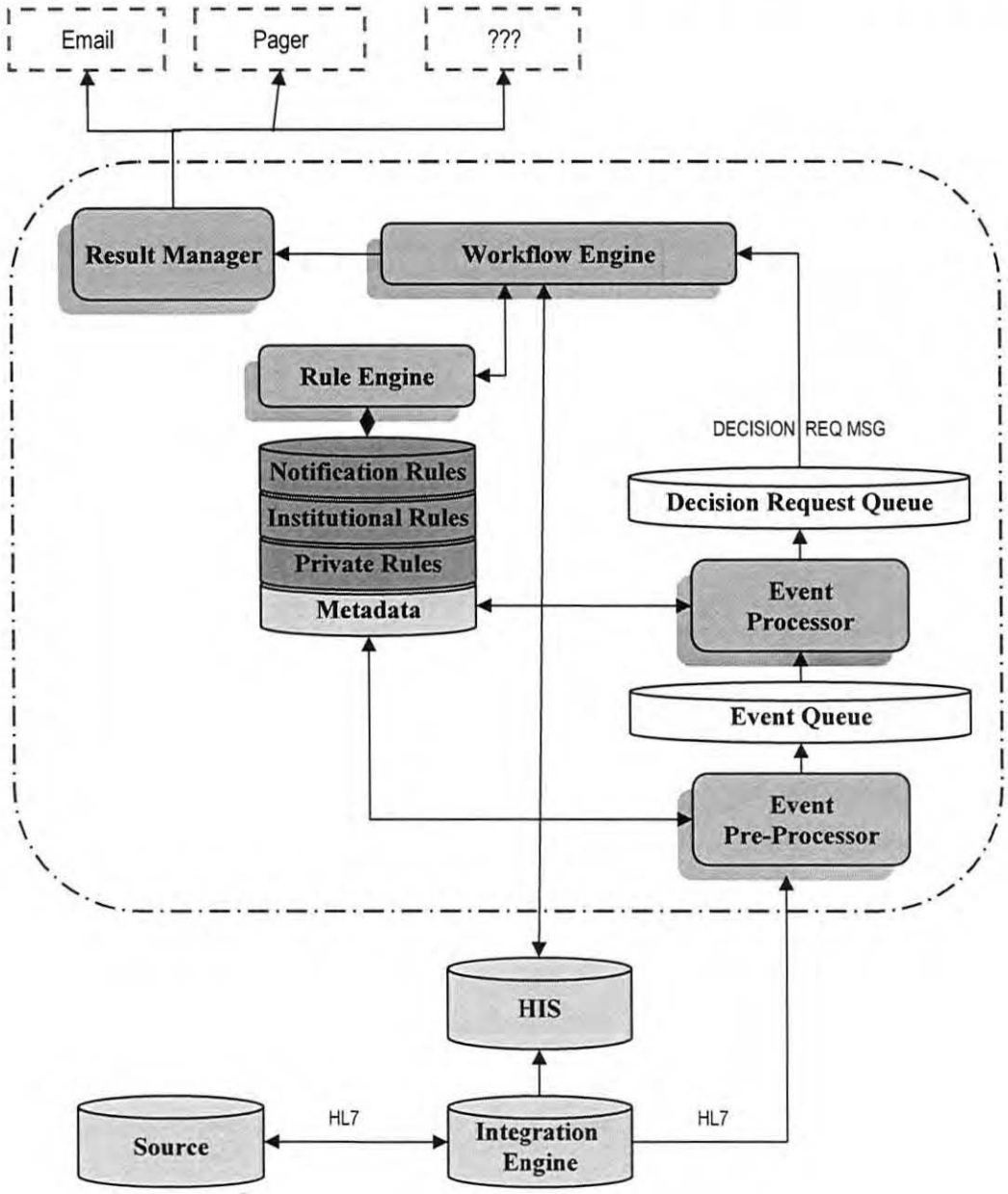
emory.fry@med.navy.mil

AIM #5

- Conduct hypothesis driven usability and outcomes research on the resulting prototype and submit research for academic publication.

emory.fry@med.navy.mil

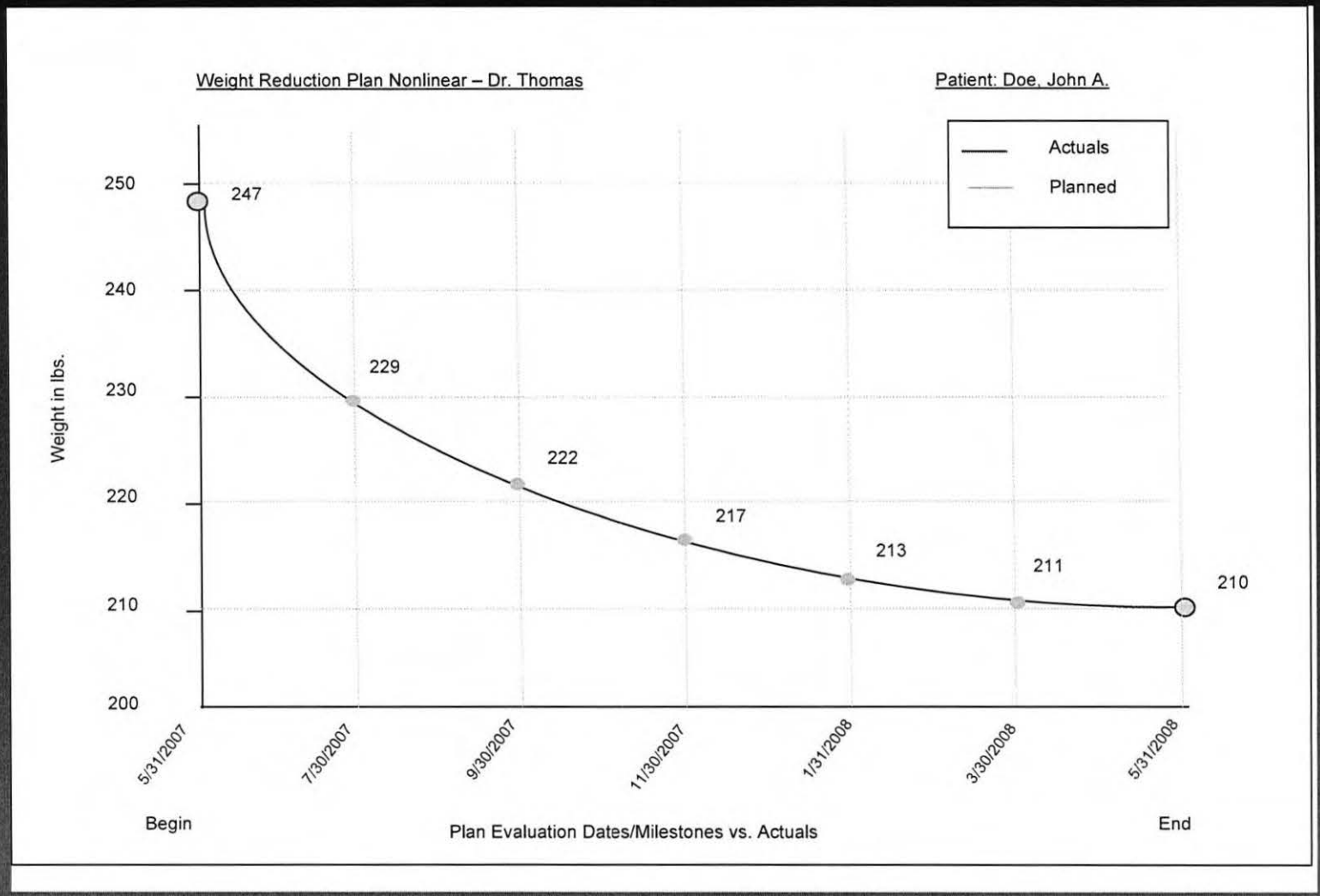
Distributed Decision Support System Architecture



Milestones To Health

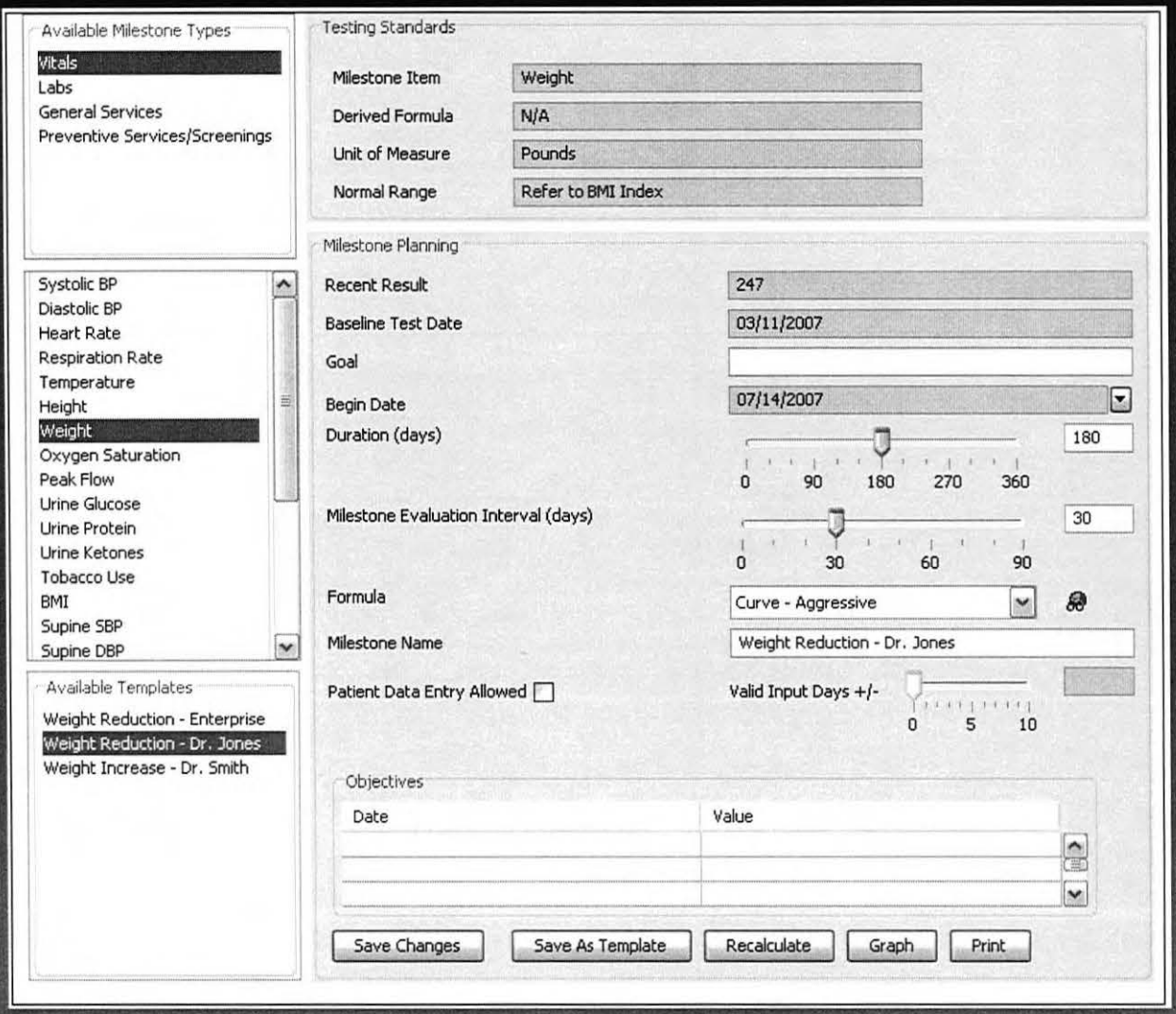
emory.fry@med.navy.mil

Personalized Careplan



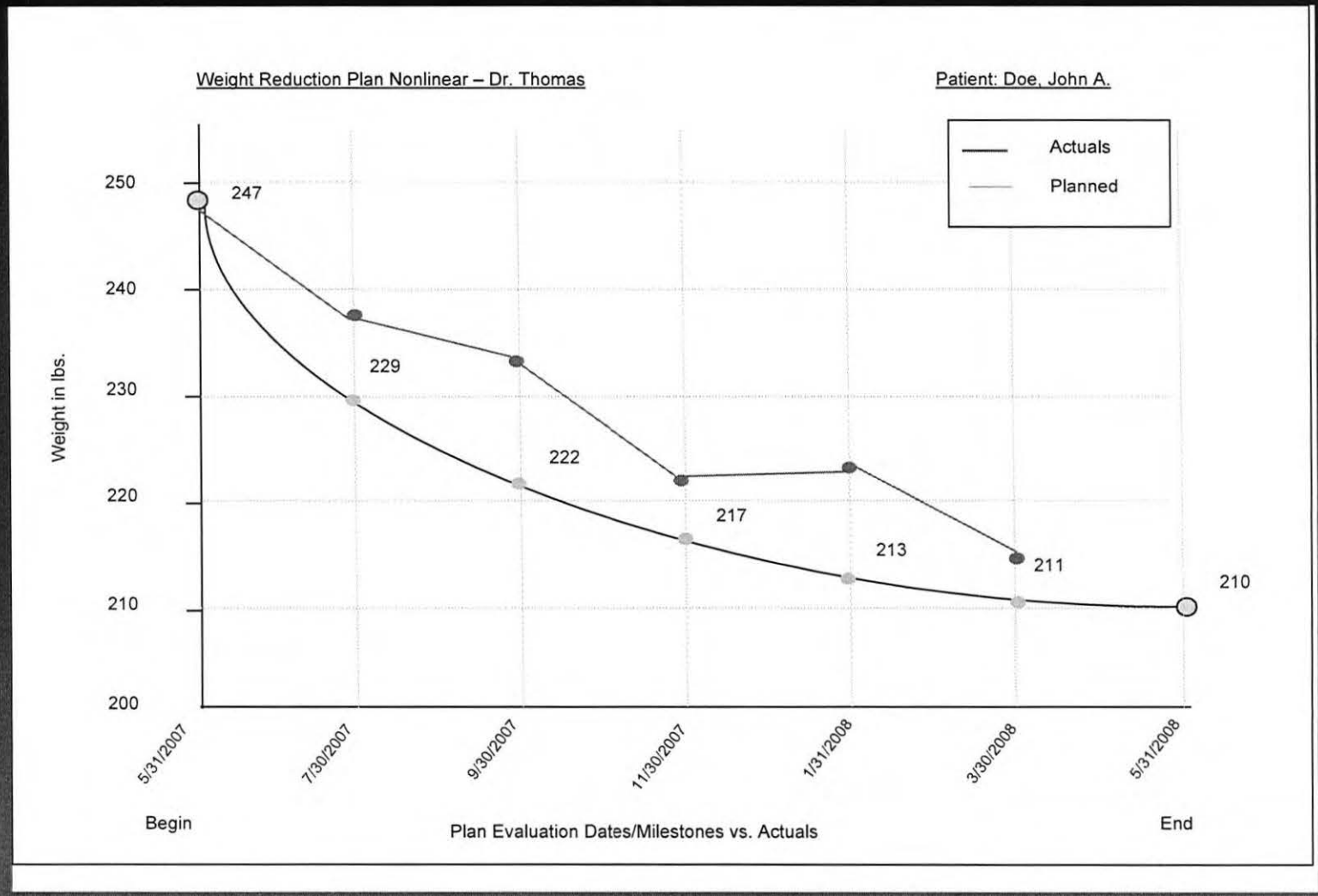
emory.fry@med.navy.mil

“Milestones” Editor



emory.fry@med.navy.mil

Careplan Runtime Engine



emory.fry@med.navy.mil

Proposal

- Invite CDS Collaboratory to:
  - Participate / contribute to requirements and system design
  - Help coordinate other federal assets towards / further development of capabilities as resources / timeline permits
- Use KMR project as advanced concept development for a CDS service on the NHIN-Connect platform

emory.fry@med.navy.mil

Questions?

emory.fry@med.navy.mil

A Model for Sharing Knowledge and Tools for Clinical Decision Support Driven by a Use Case Requiring Interoperable Delivery in the AHLTA Environment: A Collaborative Partnership of the Morningside Initiative with the Department of Defense

Douglas B. Fridsma, MD, PhD[1], Emory Fry, MD[2], Peter J Haug, MD[3]; Mary Goldstein, MD, MSc[4], Robert A. Greenes, MD, PhD[1]

[1]Arizona State University, Phoenix, AZ;
[2]Naval Health Research Center, San Diego, CA
[3]Intermountain Healthcare System, Salt Lake City, UT
[4]VA Palo Alto Health Care System, Palo Alto, CA

Abstract

Many organizations have developed clinical decision support (CDS) content, but sharing of the work among different organizations has been limited. Several groups are exploring the many reasons for these collaborative difficulties, The Morningside Initiative is a public-private partnership to develop a model for generalizing, sharing, and reusing best available clinical decision support content. The Knowledge Management Repository (KMR) project a research program sponsored by the Department of Defense seeking to develop the infrastructure required for the Military Health System to accept and execute computable guidelines within its runtime environment.

This panel describes a unique collaboration between the Morningside Initiative and the KMR project to combine their initiatives to jointly determine the functional requirements developing interoperable CDS capabilities. We describe the current implementation, its relationship to the National Health Information Network (NHIN) infrastructure, and the goal of demonstrating a functional prototype using the Department of Defense clinical data repository and bedside client.

Introduction

In August, 2007, a workshop sponsored by the Telemedicine and Advance Research Center (TATRC) at the Morningside Inn in Frederick, MD, addressed the prospect of stimulating approaches to shared knowledge management for clinical decision support (CDS). The workshop was moderated by Dr. Robert Greenes M.D., Ph.D., and attended by representatives from the DoD, including the Veterans Health Administration (VHA), Department of Defense (DoD), Kaiser Permanente, Partners Healthcare and Henry Ford Healthcare System, the American Medical Informatics Association (AMIA), Office of the National Coordinator for Health Information Technology (ONC), the Agency for Healthcare Research and Quality (AHRQ) and TATRC. The consensus of the participants was that an open source, open standard, vendor-agnostic infrastructure would enable organizations to work together to develop and exchange clinical content, technology, tools and processes in applied CDS. The system could improve quality of care through technology such as reminders, alerts, guidelines, and order sets. It would decrease development time and the costs of enterprise-specific knowledge management efforts. The participants established the Morningside Initiative to pursue this vision, subsequently adding Intermountain Health and Arizona State University as collaborators.

Concurrently, the DoD was investigating the operational execution of clinical practice guidelines within the military health system It project sought to augment and refocus existing information technology capabilities within the agency on the functional requirements for a Knowledge Management Repository (KMR) and Clinical Decision Support Engine.. This project was leveraging its Service Oriented Architecture approach to the Nationwide Health Information Network (NHIN) technology to address the needs of the broader clinical decision support community.

Recognizing a unique opportunity, project leaders for both the Morningside Initiative and the KMR project established a unique partnership and now collaborate in clinical decision support and content management research. The KMR project provides a tactical platform for interoperable delivery and local management of domain knowledge, while the Morningside Initiative contributes its considerable research and academic expertise to the defining the functional requirements for knowledge acquisition

analysis, representation, and management for site-specific execution.

Panel Topics and Structure

(Fridsma) Moderator and framing of purpose of panel

(Greenes) Review of prior and ongoing collaborative projects related to CDS, and unique aspects of the Morningside-KMR collaboration.

(Haug) Describe the development of functional requirements and models to support a standard format for representing CDS knowledge. This will address the separation of the business/operations knowledge from the clinical knowledge, and provide insight into how CDS rules, drawn from different organizations can be normalized and placed in a common repository.

(Goldstein) Translating clinical knowledge embedded in computable formats for one health care system's electronic record to standardized format for sharing with other systems. This presentation will illustrate issues that arise in this translation and the insights gained from translating several different reminders and other fragments of clinical knowledge.

(Fry) The Federal CDS implementation in the context of AHLTA and the NHIN . This presentation will describe the NHIN adapter in more detail and how the CDS systems developed in the KMR project and the work of the Morningside Initiative will be used to deliver CDS within the NHIN infrastructure.

Panel Participants

Douglas B Fridsma, MD PhD

Associate Professor, Department of Biomedical Informatics, Arizona State University, Arizona Biomedical Collaborative, 425 N. 5th St., Phoenix, AZ 85004-2157, Tel: 602-827-2515, Email: fridsma@asu.edu

Robert A. Greenes, MD, PhD

Ira A. Fulton Chair and Professor, Department of Biomedical Informatics, Arizona State University, Arizona Biomedical Collaborative, 425 N. 5th St., Phoenix, AZ 85004-2157, Tel: 602-827-2548, Email: greenes@asu.edu

Mary K. Goldstein M.D., MSc

Professor of Medicine in the Center for Primary Care and Outcomes Research and of Health Research and Policy (by courtesy), Stanford University School of Medicine, and Director, Geriatrics Research Education and Clinical Center (GRECC), VA Palo Alto Health Care System, Geriatrics Research Education & Clinical Center (GRECC) 182-B, 3801 Miranda Avenue, Palo Alto, CA 94304 email: Mary.Goldstein@va.gov

Peter Haug, MD

Director, Homer Warner Center for Informatics Research at Intermountain Healthcare and Professor, Department of Biomedical Informatics at the University of Utah. Salt Lake City, Utah. Email: Peter.Haug@imail.org

Emory Fry, MD

Assistant Professor of Pediatrics, Uniformed Services University for Health Sciences, Neonatologist, Naval Medical Center, San Diego and informatics researcher, Naval Health Research Center, San Diego, CA. email: emory.fry@med.navy.mil

All panel participants have agreed to take part on the panel.

The KMR project is supported by Award Number: W81XWH-06-2-0074 awarded and administered through the U.S. Army Medical Research Acquisition Activity, 820 Chandler Street, Fort Detrick MD 21702-5014. The opinions of the authors expressed herein do not necessarily state or reflect those of the United States Government, and shall not be used for advertising or product endorsement purposes.

ID	Task Name	% Work Complete	Duration	Start	Finish	Predecessors	Resource Names
1	**Project Administration**	**39%**	**459 days?**	**Wed 1/28/09**	**Thu 10/28/10**		
2	**Initiation**	**89%**	**187 days?**	**Thu 2/26/09**	**Fri 11/13/09**		
3	**Requirements & Scope Definition**	**99%**	**125 days?**	**Thu 2/26/09**	**Wed 8/19/09**		
4	Review Existing Project Goals and Business Requirements	100%	12 days?	Thu 2/26/09	Fri 3/13/09		Emory,Peiffer,Reedy
5	Change of PI Letter to USAMRAA	100%	1 day?	Mon 3/16/09	Mon 3/16/09		Steve Stevenson
6	NHRC Change of PI Letter	100%	0.33 days?	Mon 5/11/09	Mon 5/11/09		Emory,Peiffer,Reedy
7	Contact External Stakeholders	100%	14 days	Fri 5/1/09	Wed 5/20/09	6	Emory
8	Draft NHRC/TATRC MOU	100%	1 day?	Mon 8/3/09	Mon 8/3/09		Emory
9	Final NHRC/TATRC MOU	50%	1 day?	Wed 8/19/09	Wed 8/19/09		Emory
10	**Intellectual Property**	**100%**	**1 day?**	**Thu 5/21/09**	**Thu 5/21/09**	7	
11	Establish IP SOP Consistent With FHA-NHIN-CONNECT	100%	1 day?	Thu 5/21/09	Thu 5/21/09		Emory
12	Rights and Special Works Language Determined	100%	1 day?	Thu 5/21/09	Thu 5/21/09		Emory
13	Review IP Approach With MRMC Legal	100%	1 day?	Thu 5/21/09	Thu 5/21/09		Emory
14	**Statement of Work**	**100%**	**25 days?**	**Mon 5/11/09**	**Fri 6/12/09**		
15	Draft New KMR SOW	100%	2 days?	Mon 5/11/09	Thu 5/21/09		Emory,Reedy,Peiffer
16	Review and Revise as Necessary	100%	13 days?	Mon 5/11/09	Wed 5/27/09		Emory,Reedy,Peiffer
17	Approve New KMR SOW	100%	8 days?	Thu 5/28/09	Fri 6/12/09	16	Emory,Reed,Peiffer
18	**Institutional Review Board (IRB) Consideration**	**19%**	**38 days?**	**Wed 9/23/09**	**Fri 11/13/09**		
19	Review of Proposal and SOW by NHRC, IRB Department	25%	33 days?	Wed 9/23/09	Fri 11/6/09		Chris Blood
20	Subsequent steps developed dependent on review outcome.	0%	5 days?	Mon 11/9/09	Fri 11/13/09	19	Emory,Trish
21	**Project Schedule/Plan**	**100%**	**83 days?**	**Tue 6/9/09**	**Thu 10/1/09**		
22	Create Draft	100%	49 days?	Tue 6/9/09	Fri 8/14/09		Trish,Emory
23	Review and Revise	100%	33.23 days?	Fri 8/14/09	Wed 9/30/09	22	Emory,Trish
24	Project Schedule Approved	100%	1 day?	Thu 10/1/09	Thu 10/1/09	23	Emory
25	Create Deliverable Timeline-Checklist Table	100%	5 days?	Wed 9/23/09	Tue 9/29/09		Emory,Trish

ID	Task Name	% Work Complete	Duration	Start	Finish	Predecessors	Resource Names
26	**Staffing Plan**	**100%**	**94 days?**	**Wed 1/28/09**	**Mon 6/8/09**		
27	Determine Staffing Needs	100%	1 day?	Wed 1/28/09	Wed 1/28/09		Emory
28	**Assign or Begin Hiring Process**	**100%**	**86 days?**	**Mon 2/9/09**	**Mon 6/8/09**		
29	Project Director	100%	14 days?	Wed 5/20/09	Mon 6/8/09		Emory,Christy
30	2 FTE and 1 half-time Programmer	100%	36 days?	Mon 2/9/09	Mon 6/8/09		Emory,Christy
31	**Subawards/Contracts**	**30%**	**372 days?**	**Fri 5/1/09**	**Thu 9/30/10**		
32	Determine Req. Outside Support (vendor, consulting firms, university, copyright issues)	100%	63 days?	Thu 5/28/09	Mon 8/24/09		Emory
33	**ASU Sub-Award**	**32%**	**354 days?**	**Wed 5/27/09**	**Thu 9/30/10**		**Doug,Emory,Christy,Lisa Cole**
34	**Admin Tasks**	**82%**	**103 days?**	**Wed 5/27/09**	**Fri 10/16/09**		
35	**Hosting Agreement with ASU**	**100%**	**35 days?**	**Wed 5/27/09**	**Tue 7/14/09**		**Tammy and Christy**
36	Draft Agreement	100%	34 days?	Thu 5/28/09	Tue 7/14/09		Christy,Tammy
37	Draft reviewed by Geneva	100%	34 days?	Wed 5/27/09	Mon 7/13/09		Christy
38	Draft reviewed by ASU	100%	1 day?	Wed 5/27/09	Wed 5/27/09		Tammy
39	Signed by Geneva	100%	1 day	Tue 7/14/09	Tue 7/14/09	37	Christy
40	Signed by ASU	100%	1 day?	Tue 7/14/09	Tue 7/14/09	38	Tammy
41	**ASU SOW and Budget**	**72%**	**100 days?**	**Mon 6/1/09**	**Fri 10/16/09**		**Emory,Doug**
42	Draft of ASU SOW and Budget	100%	74 days?	Mon 6/1/09	Thu 9/10/09		Emory
43	Review documents by Geneva	100%	1 day?	Thu 9/10/09	Thu 9/10/09		Christy
44	Agreement created by Geneva Foundation	100%	1 day?	Fri 9/11/09	Fri 9/11/09	43	Christy
45	Agreement for Modification Forwarded to ASU by Geneva	50%	41 days	Thu 7/16/09	Thu 9/10/09		Christy
46	Agreement for Modification Signed by ASU	0%	0 days	Fri 10/16/09	Fri 10/16/09	43,45	ASU
47	**Task Deliverables**	**0%**	**230 days?**	**Sun 11/15/09**	**Thu 9/30/10**		**ASU**
48	Academic Panel Discussion On CDS presented at AMIA	0%	1 day	Sun 11/15/09	Sun 11/15/09		ASU
49	**Academic Review of CDS 'state of the art'**	**0%**	**1 day?**	**Fri 2/26/10**	**Fri 2/26/10**		**ASU**
50	Journal-quality academic publication summarizing previous work	0%	0 days	Fri 2/26/10	Fri 2/26/10		ASU

ID	Task Name	% Work Complete	Duration	Start	Finish	Predecessors	Resource Names
51	Review functional elements of a guideline and current abstract models	0%	1 day?	Fri 2/26/10	Fri 2/26/10		ASU
52	Review languages for expressing guidelines (current syntax approaches)	0%	1 day?	Fri 2/26/10	Fri 2/26/10		ASU
53	Define missing components/ capabilities and discuss priorities	0%	1 day?	Fri 2/26/10	Fri 2/26/10		ASU
54	**Academic Presentation & Demonstration of Runtime Deliverables**	**0%**	**1 day?**	**Mon 3/1/10**	**Mon 3/1/10**		**ASU**
55	HIMSS '10 presentation of the KMR system using a demonstration use case	0%	1 day?	Mon 3/1/10	Mon 3/1/10		ASU
56	Develop a demo script and formal presentation	0%	1 day?	Mon 3/1/10	Mon 3/1/10		ASU
57	Develop supplemental content / data / metadata for demo script	0%	1 day?	Mon 3/1/10	Mon 3/1/10		ASU
58	Journal-quality academic publication	0%	0 days	Mon 3/1/10	Mon 3/1/10		ASU
59	**Academic Review of completed KMR Project**	**0%**	**1 day?**	**Thu 9/30/10**	**Thu 9/30/10**		**ASU**
60	Formal presentation of KMR/MS work @AMIA '10	0%	1 day	Thu 9/30/10	Thu 9/30/10		ASU
61	Journal-quality academic publication of work in Fall '10	0%	1 day?	Thu 9/30/10	Thu 9/30/10		ASU
62	**Academic Outcome & Usability Evaluations**	**0%**	**1 day?**	**Thu 9/30/10**	**Thu 9/30/10**		**ASU**
63	Plan and execute KMR usability evaluation at Indian Medical Center Phoenix, AZ summer 2010	0%	1 day?	Thu 9/30/10	Thu 9/30/10		ASU
64	Collect usability and outcome metrics	0%	1 day?	Thu 9/30/10	Thu 9/30/10		ASU
65	Journal-quality academic publication	0%	0 days	Thu 9/30/10	Thu 9/30/10		ASU
66	**Document Metadata, Terminologies & Value Sets for Runtime Engine and Knowledge Management**	**0%**	**1 day?**	**Fri 2/26/10**	**Fri 2/26/10**		**ASU**
67	Document the Knowledge Module information model based on the functional and semantic requirements for	0%	1 day?	Fri 2/26/10	Fri 2/26/10		ASU
68	Identify standardized terminologies for value sets (i.e., LOINC, SNOMED, etc) or create "placeholder" value sets for concepts without exiting applicable	0%	1 day?	Fri 2/26/10	Fri 2/26/10		ASU
69	**Medsphere Sub-Award**	**1%**	**298 days?**	**Fri 7/24/09**	**Fri 9/10/10**		
70	**Admin Tasks**	**13%**	**86 days?**	**Fri 7/24/09**	**Wed 11/18/09**		
71	Draft SOW and Budget to Geneva for Review	0%	43 days?	Fri 7/24/09	Tue 9/22/09		Emory
72	Review of documents by Geneva	50%	1 day?	Fri 10/9/09	Fri 10/9/09	71	Christy
73	Sole Source Justification	100%	5 days?	Tue 8/25/09	Mon 8/31/09		Emory
74	Agreement for Modification Forwarded to Medsphere by Geneva	100%	1 day	Mon 10/12/09	Mon 10/12/09	72	Christy
75	Agreement for Modification Signed by Medsphere	100%	0 days	Wed 11/18/09	Wed 11/18/09	74	MEDSPHERE

ID	Task Name	% Work Complete	Duration	Start	Finish	Predecessors	Resource Names
76	**Task Deliverables**	**0%**	**227 days?**	**Mon 11/2/09**	**Fri 9/10/10**		
77	**Establish SCRUM based development environment**	**0%**	**13 days?**	**Mon 11/2/09**	**Mon 11/16/09**		**MEDSPHERE**
78	Host Medsphere/KMR planning and kick-off meeting	0%	1 day?	Mon 11/2/09	Mon 11/2/09		MEDSPHERE
79	Implement Medsphere SCRUM and Sprint planning process	0%	1 day?	Mon 11/2/09	Mon 11/2/09		MEDSPHERE
80	Validate KMR task requirements and system design within RPMS Infrastructure.	0%	4 days	Tue 11/3/09	Fri 11/6/09		MEDSPHERE
81	Deliver Research Development Plan	0%	5 days	Mon 11/9/09	Fri 11/13/09		MEDSPHERE
82	Obtain Government approval of Research Development Plan.	0%	1 day?	Mon 11/16/09	Mon 11/16/09		MEDSPHERE
83	**Develop and Implement web service data access tier for**	**0%**	**75 days?**	**Mon 11/16/09**	**Fri 2/26/10**		**MEDSPHERE**
84	Create and deliver Requirements and Design Documents.	0%	11 days?	Mon 11/16/09	Mon 11/30/09		MEDSPHERE
85	Develop Web Services	0%	65 days?	Mon 11/30/09	Fri 2/26/10		MEDSPHERE
86	Update existing API documentation as requirement	0%	51 days?	Mon 11/30/09	Mon 2/8/10		MEDSPHERE
87	Deliver Source Code.	0%	1 day?	Mon 2/8/10	Mon 2/8/10		MEDSPHERE
88	**Incorporate KMR GUI Services and CDS Service Infrastr**	**0%**	**36 days?**	**Mon 11/16/09**	**Mon 1/4/10**		**MEDSPHERE**
89	Create and deliver Requirements and Design Documents	0%	10 days?	Mon 11/16/09	Fri 11/27/09		MEDSPHERE
90	Integrate KMR Messaging Infrastructure	0%	29 days?	Mon 11/16/09	Thu 12/24/09		MEDSPHERE
91	Integrate MedAlert screens/functionality to interact with surfaced alerts.	0%	21 days?	Mon 12/7/09	Mon 1/4/10		MEDSPHERE
92	Update User Interface Framework API documentation	0%	21 days?	Mon 12/7/09	Mon 1/4/10		MEDSPHERE
93	Deliver Source Code	0%	1 day?	Mon 1/4/10	Mon 1/4/10		MEDSPHERE
94	**Optimize Open Source Drools Infrastructure for clinical**	**0%**	**227 days?**	**Mon 11/2/09**	**Fri 9/10/10**		**MEDSPHERE**
95	Create and deliver Requirements and Design Documents.	0%	215 days?	Mon 11/16/09	Fri 9/10/10		MEDSPHERE
96	Expose Drools inference engine functional capabilities as a callable web service	0%	36 days?	Mon 11/16/09	Mon 1/4/10		MEDSPHERE
97	Ensure semantic constraint and terminology conformance during rule authoring	0%	40 days?	Mon 1/4/10	Fri 2/26/10		MEDSPHERE
98	Incorporate Drools rules repository into KMR data model	0%	65 days?	Mon 3/1/10	Fri 5/28/10		MEDSPHERE
99	Develop infrastructure framework for robust authoring of rules	0%	45 days?	Mon 5/31/10	Fri 7/30/10		MEDSPHERE
100	Provide rule test and evaluation tools to load, execute and analyze rule logic / integrity, and performance	0%	25 days?	Mon 8/2/10	Fri 9/3/10		MEDSPHERE
101	Update Drools documentation.	0%	222 days?	Mon 11/2/09	Fri 9/3/10		MEDSPHERE
102	**SOADEX Sub-Award**	**50%**	**372 days?**	**Fri 5/1/09**	**Thu 9/30/10**		

ID	Task Name	% Work Complete	Duration	Start	Finish	Predecessors	Resource Names
103	**Admin Tasks**	**100%**	**115 days?**	**Fri 5/1/09**	**Thu 10/8/09**		
104	Draft SOW and Budget to Geneva for Review	100%	57 days?	Fri 5/1/09	Mon 7/20/09		Fateh,Emory
105	Review of documents by Geneva/SOADEX	100%	4 days?	Tue 7/21/09	Fri 7/24/09	104	Christy,Fateh
106	Sole Source Justification	100%	52 days?	Fri 5/8/09	Mon 7/20/09		Emory
107	Agreement created by Geneva Foundation	100%	1 day?	Fri 7/24/09	Sat 7/25/09	106	Christy
108	Agreement Forwarded to SOADEX by Geneva	100%	7 days	Fri 9/25/09	Mon 10/5/09		Christy
109	Agreement Signed by SOADEX	100%	1 day	Tue 10/6/09	Tue 10/6/09	105,108	SOADEX
110	**Modification to Agreement**	**100%**	**63 days?**	**Tue 7/14/09**	**Thu 10/8/09**		**Fateh,Emory**
111	Modification Written and Forwarded to Geneva	100%	51 days?	Tue 7/14/09	Tue 9/22/09		Emory
112	Agreement for Modification Forwarded to SOADEX by Geneva	100%	1 day?	Thu 10/8/09	Thu 10/8/09	111	Christy
113	Agreement for Modification Signed by SOADEX	100%	1 day?	Thu 10/8/09	Thu 10/8/09		SOADEX
114	**Task Deliverables**	**34%**	**354 days?**	**Wed 5/27/09**	**Thu 9/30/10**		**SOADEX**
115	**Phase 1 - Preliminary Requirement and System Design Review**	**100%**	**57 days**	**Wed 5/27/09**	**Thu 8/13/09**		**SOADEX**
116	Provide a Draft of Functional Requirement Document detailing system funcational capabilities	100%	26 days	Wed 5/27/09	Wed 7/1/09		SOADEX
117	Preliminary Project Plan	100%	57 days	Wed 5/27/09	Thu 8/13/09		SOADEX
118	Plan and Facilitate Requirement Review Meetings	100%	3 days	Wed 5/27/09	Fri 5/29/09		SOADEX
119	**Phase 2 -Final Functional Requirements, Use Case Documentation, UML Artifacts and Meeting**	**100%**	**4 days?**	**Wed 7/1/09**	**Mon 7/6/09**		**SOADEX**
120	Subject Matter Expert Requirement Review	100%	4 days?	Wed 7/1/09	Mon 7/6/09		SOADEX
121	Final Functional Requirements Document	100%	4 days?	Wed 7/1/09	Mon 7/6/09		SOADEX
122	**Phase 3 - "Final system Design Documentation, UML, Artifacts, meeting facilitation, and Engineering Plan"**	**100%**	**26 days**	**Fri 7/10/09**	**Sat 8/15/09**		**SOADEX**
123	KMR Schema and KMR Documentation	100%	26 days	Fri 7/10/09	Sat 8/15/09		SOADEX
124	Final Project Plan and Engineering Plan	100%	9 days	Sat 8/1/09	Thu 8/13/09		SOADEX
125	Final System Design Documentation	100%	25 days	Mon 7/13/09	Sat 8/15/09		SOADEX
126	**Phase 4 - Final Quality Assurance Plan and Testing Services**	**0%**	**255 days?**	**Tue 10/13/09**	**Thu 9/30/10**		**SOADEX**
127	Final Quality Assurance Plan	0%	11 days	Tue 10/13/09	Tue 10/27/09		SOADEX

ID	Task Name	% Work Complete	Duration	Start	Finish	Predecessors	Resource Names
128	Quality Assurance & Testing Services	0%	244 days?	Wed 10/28/09	Thu 9/30/10		SOADEX
129	**Budget**	**100%**	**93 days?**	**Mon 6/8/09**	**Thu 10/15/09**		
130	**Admin Tasks**	**100%**	**65 days?**	**Thu 7/16/09**	**Thu 10/15/09**		
131	Indirect Funding Source Determined	100%	26 days?	Thu 7/16/09	Thu 8/20/09		Emory
132	Budget documentation forwarded to Geneva	100%	1 day	Fri 9/25/09	Fri 9/25/09		Emory
133	Submit Budget for Approval	100%	1 day	Fri 10/2/09	Fri 10/2/09		Christy
134	Budget Approved	100%	0 days	Thu 10/15/09	Thu 10/15/09		Lisa
135	**Travel**	**100%**	**77 days?**	**Mon 6/8/09**	**Tue 9/22/09**		
136	Itemize and Justify	100%	77 days?	Mon 6/8/09	Tue 9/22/09		Emory
137	Pricing	100%	77 days?	Mon 6/8/09	Tue 9/22/09		Emory
138	**Supplies**	**100%**	**77 days?**	**Mon 6/8/09**	**Tue 9/22/09**		
139	Itemization Cost	100%	77 days?	Mon 6/8/09	Tue 9/22/09		Emory
140	**Equipment**	**100%**	**60 days?**	**Mon 6/8/09**	**Fri 8/28/09**		
141	Justifications including any "sole source" purchases	100%	60 days?	Mon 6/8/09	Fri 8/28/09		Emory
142	Quotes	100%	60 days?	Mon 6/8/09	Fri 8/28/09		Emory
143	**Reporting**	**33%**	**350 days?**	**Tue 6/30/09**	**Thu 10/28/10**		
144	**Quarterly Reporting to USAMRAA**	**43%**	**275 days?**	**Tue 6/30/09**	**Thu 7/15/10**		
145	Apr - Jun 2009 Period	100%	12 days?	Tue 6/30/09	Wed 7/15/09		Trish,Emory
146	Jul - Sept 2009 Period	100%	12 days?	Wed 9/30/09	Thu 10/15/09		Trish,Emory
147	Oct - Dec 2009 Period	0%	13 days?	Wed 12/30/09	Fri 1/15/10		Trish,Emory
148	Jan - Mar 2010 Period	0%	6.5 days?	Wed 4/7/10	Thu 4/15/10		Trish,Emory
149	April - June 2010 Period	0%	6.5 days?	Wed 6/30/10	Thu 7/8/10		Trish,Emory
150	Jul - Sept 2010 Period	0%	6 days?	Thu 7/8/10	Thu 7/15/10		Trish,Emory
151	**Yearly Report to USAMRAA**	**5%**	**273 days?**	**Thu 10/15/09**	**Thu 10/28/10**		
154	**Engineering**	**46%**	**427 days?**	**Mon 2/16/09**	**Fri 10/1/10**		

ID	Task Name	% Work Complete	Duration	Start	Finish	Predecessors	Resource Names
155	**Release #1**	**96%**	**195 days**	**Mon 2/16/09**	**Fri 11/13/09**		
156	**Sprint 1 (Set-Up)**	**100%**	**10 days**	**Mon 2/16/09**	**Fri 2/27/09**		
157	**Sprint Planning**	**100%**	**1 day**	**Mon 2/16/09**	**Mon 2/16/09**		
158	User Story Additions	100%	1 day	Mon 2/16/09	Mon 2/16/09		Emory
159	Backlog Prioritization	100%	1 day	Mon 2/16/09	Mon 2/16/09		KMR Team
160	Documentation Review	100%	1 day	Mon 2/16/09	Mon 2/16/09		KMR Team
161	**Deliverables**	**100%**	**9 days**	**Tue 2/17/09**	**Fri 2/27/09**		
162	Development & QA Environment Setup	100%	9 days	Tue 2/17/09	Fri 2/27/09		KMR Team
163	Team Collaboration Wiki	100%	9 days	Tue 2/17/09	Fri 2/27/09		KMR Team
164	Source Code Repository	100%	9 days	Tue 2/17/09	Fri 2/27/09		KMR Team
165	Software Defect Tracking System	100%	9 days	Tue 2/17/09	Fri 2/27/09		KMR Team
166	**Sprint 2 (DDSS Install)**	**100%**	**10 days**	**Mon 3/2/09**	**Fri 3/13/09**	**156**	
167	**Sprint Planning**	**100%**	**1 day**	**Mon 3/2/09**	**Mon 3/2/09**		
168	User Story Additions	100%	1 day	Mon 3/2/09	Mon 3/2/09		Emory
169	Backlog Prioritization	100%	1 day	Mon 3/2/09	Mon 3/2/09		KMR Team
170	Documentation Review	100%	1 day	Mon 3/2/09	Mon 3/2/09		KMR Team
171	**Deliverables**	**100%**	**9 days**	**Tue 3/3/09**	**Fri 3/13/09**		
172	Install existing Fact Handler	100%	9 days	Tue 3/3/09	Fri 3/13/09		KMR Team
173	Install existing Task Manager	100%	9 days	Tue 3/3/09	Fri 3/13/09		KMR Team
174	Install existing Mirth Integration engine	100%	9 days	Tue 3/3/09	Fri 3/13/09		KMR Team
175	Install existing Oracle Jess Rules engine	100%	9 days	Tue 3/3/09	Fri 3/13/09		KMR Team
176	**Sprint 3 (Requirements #1)**	**100%**	**10 days**	**Mon 3/16/09**	**Fri 3/27/09**	**166**	
177	**Sprint Planning**	**100%**	**1 day**	**Mon 3/16/09**	**Mon 3/16/09**		
178	User Story Additions	100%	1 day	Mon 3/16/09	Mon 3/16/09		Emory
179	Backlog Prioritization	100%	1 day	Mon 3/16/09	Mon 3/16/09		KMR Team

ID	Task Name	% Work Complete	Duration	Start	Finish	Predecessors	Resource Names
180	Documentation Review	100%	1 day	Mon 3/16/09	Mon 3/16/09		KMR Team
181	**Deliverables**	**100%**	**9 days**	**Tue 3/17/09**	**Fri 3/27/09**		
182	Review/document current middle tier functions	100%	9 days	Tue 3/17/09	Fri 3/27/09		KMR Team
183	Review/document functional scenarios	100%	9 days	Tue 3/17/09	Fri 3/27/09		SOADEX
184	**Sprint 4 (Requirements #2)**	**100%**	**10 days**	**Mon 3/30/09**	**Fri 4/10/09**	**176**	
185	**Sprint Planning**	**100%**	**1 day**	**Mon 3/30/09**	**Mon 3/30/09**		
189	**Deliverables**	**100%**	**9 days**	**Tue 3/31/09**	**Fri 4/10/09**		
190	Identify "Milestones To Health" requirements	100%	9 days	Tue 3/31/09	Fri 4/10/09		KMR Team
191	Identify Provider Inbox requirements	100%	9 days	Tue 3/31/09	Fri 4/10/09		KMR Team
192	Identify MedAlert requirements.	100%	9 days	Tue 3/31/09	Fri 4/10/09		KMR Team
193	Identify Rule Workbench's requirements	100%	9 days	Tue 3/31/09	Fri 4/10/09		KMR Team
194	Identify Patient Medical Record requirements	100%	9 days	Tue 3/31/09	Fri 4/10/09		KMR Team
195	**Sprint 5 (Design)**	**100%**	**10 days**	**Mon 4/13/09**	**Fri 4/24/09**	**184**	
196	**Sprint Planning**	**100%**	**1 day**	**Mon 4/13/09**	**Mon 4/13/09**		
197	User Story Additions	100%	1 day	Mon 4/13/09	Mon 4/13/09		Emory
198	Backlog Prioritization	100%	1 day	Mon 4/13/09	Mon 4/13/09		KMR Team
199	Documentation Review	100%	1 day	Mon 4/13/09	Mon 4/13/09		KMR Team
200	**Deliverables**	**100%**	**9 days**	**Tue 4/14/09**	**Fri 4/24/09**		
201	Review/document Mirth Channels Design	100%	9 days	Tue 4/14/09	Fri 4/24/09		KMR Team
202	Review/document Event Service Design	100%	9 days	Tue 4/14/09	Fri 4/24/09		KMR Team
203	Review/document Data Transformation Service Design	100%	9 days	Tue 4/14/09	Fri 4/24/09		KMR Team
204	Review/document Clinical Decision Support Service Design	100%	9 days	Tue 4/14/09	Fri 4/24/09		KMR Team
205	Review/document Knowledge Management Service Design	100%	9 days	Tue 4/14/09	Fri 4/24/09		KMR Team
206	Review/document Task Service Design	100%	9 days	Tue 4/14/09	Fri 4/24/09		KMR Team
207	Review/document GUI Service Design	100%	9 days	Tue 4/14/09	Fri 4/24/09		KMR Team

ID	Task Name	% Work Complete	Duration	Start	Finish	Predecessors	Resource Names
208	Review/document Common Access Layer Design	100%	9 days	Tue 4/14/09	Fri 4/24/09		KMR Team
209	Review/document Bus Orchestration Service Design	100%	9 days	Tue 4/14/09	Fri 4/24/09		KMR Team
210	**Sprint 6 (Design)**	**100%**	**10 days**	**Mon 4/27/09**	**Fri 5/8/09**	**195**	
211	**Sprint Planning**	**100%**	**1 day**	**Mon 4/27/09**	**Mon 4/27/09**		
212	User Story Additions	100%	1 day	Mon 4/27/09	Mon 4/27/09		Emory
213	Backlog Prioritization	100%	1 day	Mon 4/27/09	Mon 4/27/09		KMR Team
214	Documentation Review	100%	1 day	Mon 4/27/09	Mon 4/27/09		KMR Team
215	**Deliverables**	**100%**	**9 days**	**Tue 4/28/09**	**Fri 5/8/09**		
216	Review/document MedAlert Design	100%	9 days	Tue 4/28/09	Fri 5/8/09		KMR Team
217	Review/document MedAlert Design	100%	9 days	Tue 4/28/09	Fri 5/8/09		KMR Team
218	Review/document MedAlert Design	100%	9 days	Tue 4/28/09	Fri 5/8/09		KMR Team
219	Review/document MedAlert Design	100%	9 days	Tue 4/28/09	Fri 5/8/09		KMR Team
220	Review/document MedAlert Design	100%	9 days	Tue 4/28/09	Fri 5/8/09		KMR Team
221	Review/document MedAlert Design	100%	9 days	Tue 4/28/09	Fri 5/8/09		KMR Team
222	**Sprint 7 (Mirth Channels)**	**100%**	**10 days**	**Mon 5/11/09**	**Fri 5/22/09**	**210**	
223	**Sprint Planning**	**100%**	**1 day**	**Mon 5/11/09**	**Mon 5/11/09**		
224	User Story Additions	100%	1 day	Mon 5/11/09	Mon 5/11/09		Emory
225	Backlog Prioritization	100%	1 day	Mon 5/11/09	Mon 5/11/09		KMR Team
226	Documentation Review	100%	1 day	Mon 5/11/09	Mon 5/11/09		KMR Team
227	**Deliverables**	**100%**	**9 days**	**Tue 5/12/09**	**Fri 5/22/09**		
228	Intial Implementation of Mirth Channels as NHIN Service	100%	9 days	Tue 5/12/09	Fri 5/22/09		KMR Team
229	**Sprint 8 (Initial Documentation)**	**100%**	**10 days**	**Mon 5/25/09**	**Fri 6/5/09**	**222**	
230	**Sprint Planning**	**100%**	**1 day**	**Mon 5/25/09**	**Mon 5/25/09**		
231	User Story Additions	100%	1 day	Mon 5/25/09	Mon 5/25/09		Emory
232	Backlog Prioritization	100%	1 day	Mon 5/25/09	Mon 5/25/09		KMR Team

ID	Task Name	% Work Complete	Duration	Start	Finish	Predecessors	Resource Names
233	Documentation Review	100%	1 day	Mon 5/25/09	Mon 5/25/09		KMR Team
234	**Deliverables**	**100%**	**9 days**	**Tue 5/26/09**	**Fri 6/5/09**		
235	Deliver Initial Documentation Set	100%	9 days	Tue 5/26/09	Fri 6/5/09		KMR Team
236	**Sprint 9 (Fact Handler Component)**	**100%**	**10 days**	**Mon 6/8/09**	**Fri 6/19/09**	**229**	
237	**Sprint Planning**	**100%**	**1 day**	**Mon 6/8/09**	**Mon 6/8/09**		
238	User Story Additions	100%	1 day	Mon 6/8/09	Mon 6/8/09		Emory
239	Backlog Prioritization	100%	1 day	Mon 6/8/09	Mon 6/8/09		KMR Team
240	Documentation Review	100%	1 day	Mon 6/8/09	Mon 6/8/09		KMR Team
241	**Deliverables**	**100%**	**9 days**	**Tue 6/9/09**	**Fri 6/19/09**		
242	Intial Implementation of Fact Handler as NHIN Service	100%	9 days	Tue 6/9/09	Fri 6/19/09		KMR Team
243	**Sprint 10 (Event Service)**	**100%**	**10 days**	**Mon 6/22/09**	**Fri 7/3/09**	**236**	
244	**Sprint Planning**	**100%**	**1 day**	**Mon 6/22/09**	**Mon 6/22/09**		
245	User Story Additions	100%	1 day	Mon 6/22/09	Mon 6/22/09		Emory
246	Backlog Prioritization	100%	1 day	Mon 6/22/09	Mon 6/22/09		KMR Team
247	Documentation Review	100%	1 day	Mon 6/22/09	Mon 6/22/09		KMR Team
248	**Deliverables**	**100%**	**9 days**	**Tue 6/23/09**	**Fri 7/3/09**		
249	Intial Implementation of Event Service as NHIN Service	100%	9 days	Tue 6/23/09	Fri 7/3/09		KMR Team
250	**Sprint 11 Clinical Decision Support Serivce**	**100%**	**10 days**	**Mon 7/6/09**	**Fri 7/17/09**	**243**	
251	**Sprint Planning**	**100%**	**1 day**	**Mon 7/6/09**	**Mon 7/6/09**		
252	User Story Additions	100%	1 day	Mon 7/6/09	Mon 7/6/09		Emory
253	Backlog Prioritization	100%	1 day	Mon 7/6/09	Mon 7/6/09		KMR Team
254	Documentation Review	100%	1 day	Mon 7/6/09	Mon 7/6/09		KMR Team
255	**Deliverables**	**100%**	**9 days**	**Tue 7/7/09**	**Fri 7/17/09**		
256	Intial Implementation of Clinical Decision Support Service as NHIN Service	100%	9 days	Tue 7/7/09	Fri 7/17/09		KMR Team
257	**Sprint 12 (KMR Data Model)**	**100%**	**10 days**	**Mon 7/20/09**	**Fri 7/31/09**	**250**	

ID	Task Name	% Work Complete	Duration	Start	Finish	Predecessors	Resource Names
258	**Sprint Planning**	**100%**	**1 day**	**Mon 7/20/09**	**Mon 7/20/09**		
259	User Story Additions	100%	1 day	Mon 7/20/09	Mon 7/20/09		Emory
260	Backlog Prioritization	100%	1 day	Mon 7/20/09	Mon 7/20/09		KMR Team
261	Documentation Review	100%	1 day	Mon 7/20/09	Mon 7/20/09		KMR Team
262	**Deliverables**	**100%**	**9 days**	**Tue 7/21/09**	**Fri 7/31/09**		
263	Intial Implementation of KMR Schema	100%	9 days	Tue 7/21/09	Fri 7/31/09		KMR Team
264	**Sprint 13 (Rule Policy Manager and Final Design)**	**100%**	**10 days**	**Mon 8/3/09**	**Fri 8/14/09**	**257**	
265	**Sprint Planning**	**100%**	**1 day**	**Mon 8/3/09**	**Mon 8/3/09**		
266	User Story Additions	100%	1 day	Mon 8/3/09	Mon 8/3/09		Emory
267	Backlog Prioritization	100%	1 day	Mon 8/3/09	Mon 8/3/09		KMR Team
268	Documentation Review	100%	1 day	Mon 8/3/09	Mon 8/3/09		KMR Team
269	**Deliverables**	**100%**	**9 days**	**Tue 8/4/09**	**Fri 8/14/09**		
270	Intial Implementation of Rule Policy Manager as NHIN Service	100%	9 days	Tue 8/4/09	Fri 8/14/09		KMR Team
271	**Sprint 14 (Task Manager Service)**	**100%**	**10 days**	**Mon 8/17/09**	**Fri 8/28/09**	**264**	
272	**Sprint Planning**	**100%**	**1 day**	**Mon 8/17/09**	**Mon 8/17/09**		
273	User Story Additions	100%	1 day	Mon 8/17/09	Mon 8/17/09		Emory
274	Backlog Prioritization	100%	1 day	Mon 8/17/09	Mon 8/17/09		KMR Team
275	Documentation Review	100%	1 day	Mon 8/17/09	Mon 8/17/09		KMR Team
276	**Deliverables**	**100%**	**9 days**	**Tue 8/18/09**	**Fri 8/28/09**		
277	Intial Implementation of Task Manager as NHIN Service	100%	9 days	Tue 8/18/09	Fri 8/28/09		KMR Team
278	**Sprint 15 (Provider Inbox Release #1)**	**100%**	**10 days**	**Mon 8/31/09**	**Fri 9/11/09**	**271**	
279	**Sprint Planning**	**100%**	**1 day**	**Mon 8/31/09**	**Mon 8/31/09**		
280	User Story Additions	100%	1 day	Mon 8/31/09	Mon 8/31/09		Emory
281	Backlog Prioritization	100%	1 day	Mon 8/31/09	Mon 8/31/09		KMR Team
282	Documentation Review	100%	1 day	Mon 8/31/09	Mon 8/31/09		KMR Team

ID	Task Name	% Work Complete	Duration	Start	Finish	Predecessors	Resource Names
283	**Deliverables**	**100%**	**9 days**	**Tue 9/1/09**	**Fri 9/11/09**		
284	Intial Implementation of Provider Inbox as NHIN Service	100%	9 days	Tue 9/1/09	Fri 9/11/09		KMR Team
285	**Sprint 16 (Data Transformation Service)**	**100%**	**10 days**	**Mon 9/14/09**	**Fri 9/25/09**	278	
286	**Sprint Planning**	**100%**	**1 day**	**Mon 9/14/09**	**Mon 9/14/09**		
287	User Story Additions	100%	1 day	Mon 9/14/09	Mon 9/14/09		Emory
288	Backlog Prioritization	100%	1 day	Mon 9/14/09	Mon 9/14/09		KMR Team
289	Documentation Review	100%	1 day	Mon 9/14/09	Mon 9/14/09		KMR Team
290	**Deliverables**	**100%**	**9 days**	**Tue 9/15/09**	**Fri 9/25/09**		
291	Intial Implementation of Data Transformation Service as NHIN Service	100%	9 days	Tue 9/15/09	Fri 9/25/09		KMR Team
292	**Administrative Break**	**100%**	**10 days**	**Mon 9/28/09**	**Fri 10/9/09**	285	
293	New Engineering Lead and Development Process	100%	10 days	Mon 9/28/09	Fri 10/9/09		KMR Team
294	Use Cases Define for Demonstration	100%	10 days	Mon 9/28/09	Fri 10/9/09		KMR Team
295	**Sprint 17 (GUI Service)**	**0%**	**10 days**	**Mon 10/12/09**	**Fri 10/23/09**	292	
296	**Sprint Planning**	**0%**	**1 day**	**Mon 10/12/09**	**Mon 10/12/09**		
300	**Deliverables**	**0%**	**9 days**	**Tue 10/13/09**	**Fri 10/23/09**		
301	Intial Implementation of GUI Service as NHIN Service	0%	5 days	Tue 10/13/09	Fri 10/23/09		KMR Team
302	**Sprint 18 (MedAlert Release #1)**	**0%**	**10 days**	**Mon 10/26/09**	**Fri 11/6/09**	295	
303	**Sprint Planning**	**0%**	**1 day**	**Mon 10/26/09**	**Mon 10/26/09**		
304	User Story Additions	0%	1 day	Mon 10/26/09	Mon 10/26/09		Emory
305	Backlog Prioritization	0%	1 day	Mon 10/26/09	Mon 10/26/09		KMR Team
306	Documentation Review	0%	1 day	Mon 10/26/09	Mon 10/26/09		KMR Team
307	**Deliverables**	**0%**	**9 days**	**Tue 10/27/09**	**Fri 11/6/09**		
308	Intial Implementation of MedAlert as NHIN Client	0%	0 days	Tue 10/27/09	Fri 11/6/09		KMR Team
309	**Sprint 19 (Integration Testing)**	**0%**	**5 days**	**Mon 11/9/09**	**Fri 11/13/09**	302	
310	**Sprint Planning**	**0%**	**1 day**	**Mon 11/9/09**	**Mon 11/9/09**		

ID	Task Name	% Work Complete	Duration	Start	Finish	Predecessors	Resource Names
311	User Story Additions	0%	1 day	Mon 11/9/09	Mon 11/9/09		Emory
312	Backlog Prioritization	0%	1 day	Mon 11/9/09	Mon 11/9/09		KMR Team
313	Documentation Review	0%	1 day	Mon 11/9/09	Mon 11/9/09		KMR Team
314	**Deliverables**	**0%**	**4 days**	**Tue 11/10/09**	**Fri 11/13/09**		
315	Integration Testing	0%	4 days	Tue 11/10/09	Fri 11/13/09		
316	Demonstration at AMIA Meeting	0%	1 day	Sat 11/14/09	Sat 11/14/09	309	Emory
317	**Release #2**	**0%**	**75 days?**	**Mon 11/16/09**	**Fri 2/26/10**		
318	**Sprint 20 (Documentation)**	**0%**	**8 days?**	**Mon 11/16/09**	**Wed 11/25/09**		
319	**Sprint Planning**	**0%**	**1 day?**	**Mon 11/16/09**	**Mon 11/16/09**		
320	User Story Additions	0%	1 day?	Mon 11/16/09	Mon 11/16/09		
321	Backlog Prioritization	0%	1 day?	Mon 11/16/09	Mon 11/16/09		
322	Documentation Review	0%	1 day?	Mon 11/16/09	Mon 11/16/09		
323	**Deliverables**	**0%**	**7 days?**	**Tue 11/17/09**	**Wed 11/25/09**		
324	Version 2 Of KMR Documentation	0%	7 days?	Tue 11/17/09	Wed 11/25/09		KMR Team,Fateh
325	**Sprint 21 (Workbench Release #1)**	**0%**	**10 days?**	**Mon 11/30/09**	**Fri 12/11/09**		
326	**Sprint Planning**	**0%**	**1 day?**	**Mon 11/30/09**	**Mon 11/30/09**		
327	User Story Additions	0%	1 day?	Mon 11/30/09	Mon 11/30/09		
328	Backlog Prioritization	0%	1 day?	Mon 11/30/09	Mon 11/30/09		
329	Documentation Review	0%	1 day?	Mon 11/30/09	Mon 11/30/09		
330	**Deliverables**	**0%**	**9 days?**	**Tue 12/1/09**	**Fri 12/11/09**		
331	Initial Implementation of Workbench as NHIN Client	0%	9 days?	Tue 12/1/09	Fri 12/11/09		KMR Team,Fateh
332	**Sprint 22 (Admin and Performance Monitoring Tool)**	**0%**	**9 days?**	**Mon 12/14/09**	**Thu 12/24/09**		
333	**Sprint Planning**	**0%**	**1 day?**	**Mon 12/14/09**	**Mon 12/14/09**		
334	User Story Additions	0%	1 day?	Mon 12/14/09	Mon 12/14/09		
335	Backlog Prioritization	0%	1 day?	Mon 12/14/09	Mon 12/14/09		

ID	Task Name	% Work Complete	Duration	Start	Finish	Predecessors	Resource Names
336	Documentation Review	0%	1 day?	Mon 12/14/09	Mon 12/14/09		
337	**Deliverables**	**0%**	**8 days?**	**Tue 12/15/09**	**Thu 12/24/09**		
338	Initial Implementation of Admin and Performance Monitoring Tool	0%	8 days?	Tue 12/15/09	Thu 12/24/09		KMR Team,Fateh
339	**Sprint 23 (Documentation)**	**0%**	**5 days?**	**Mon 12/28/09**	**Fri 1/1/10**		
340	**Sprint Planning**	**0%**	**1 day?**	**Mon 12/28/09**	**Mon 12/28/09**		
341	User Story Additions	0%	1 day?	Mon 12/28/09	Mon 12/28/09		
342	Backlog Prioritization	0%	1 day?	Mon 12/28/09	Mon 12/28/09		
343	Documentation Review	0%	1 day?	Mon 12/28/09	Mon 12/28/09		
344	**Deliverables**	**0%**	**4 days?**	**Tue 12/29/09**	**Fri 1/1/10**		
345	Version 3 of KMR Docmentation	0%	4 days?	Tue 12/29/09	Fri 1/1/10		KMR Team,Fateh
346	**Sprint 24 (Rule Engine)**	**0%**	**10 days?**	**Mon 1/4/10**	**Fri 1/15/10**		
347	**Sprint Planning**	**0%**	**1 day?**	**Mon 1/4/10**	**Mon 1/4/10**		
348	User Story Additions	0%	1 day?	Mon 1/4/10	Mon 1/4/10		
349	Backlog Prioritization	0%	1 day?	Mon 1/4/10	Mon 1/4/10		
350	Documentation Review	0%	1 day?	Mon 1/4/10	Mon 1/4/10		
351	**Deliverables**	**0%**	**9 days?**	**Tue 1/5/10**	**Fri 1/15/10**		
352	Initial Implementation of Rule Engine	0%	9 days?	Tue 1/5/10	Fri 1/15/10		KMR Team,Fateh
353	**Sprint 25 (Workbench Release #2)**	**0%**	**10 days?**	**Mon 1/18/10**	**Fri 1/29/10**		
354	**Sprint Planning**	**0%**	**1 day?**	**Mon 1/18/10**	**Mon 1/18/10**		
355	User Story Additions	0%	1 day?	Mon 1/18/10	Mon 1/18/10		
356	Backlog Prioritization	0%	1 day?	Mon 1/18/10	Mon 1/18/10		
357	Documentation Review	0%	1 day?	Mon 1/18/10	Mon 1/18/10		
358	**Deliverables**	**0%**	**9 days?**	**Tue 1/19/10**	**Fri 1/29/10**		
359	Release #2 of the Workbench	0%	9 days?	Tue 1/19/10	Fri 1/29/10		KMR Team,Fateh
360	**Sprint 26 (MedAlert Release #2 and KMR)**	**0%**	**10 days?**	**Mon 2/1/10**	**Fri 2/12/10**		

ID	Task Name	% Work Complete	Duration	Start	Finish	Predecessors	Resource Names
361	**Sprint Planning**	**0%**	**1 day?**	**Mon 2/1/10**	**Mon 2/1/10**		
362	User Story Additions	0%	1 day?	Mon 2/1/10	Mon 2/1/10		
363	Backlog Prioritization	0%	1 day?	Mon 2/1/10	Mon 2/1/10		
364	Documentation Review	0%	1 day?	Mon 2/1/10	Mon 2/1/10		
365	**Deliverables**	**0%**	**9 days?**	**Tue 2/2/10**	**Fri 2/12/10**		
366	Release #2 of MedAlert and KMR as NHIN Client	0%	9 days?	Tue 2/2/10	Fri 2/12/10		KMR Team,Fateh
367	**Sprint 27 (Integration Testing)**	**0%**	**10 days?**	**Mon 2/15/10**	**Fri 2/26/10**		
368	**Sprint Planning**	**0%**	**1 day?**	**Mon 2/15/10**	**Mon 2/15/10**		
369	User Story Additions	0%	1 day?	Mon 2/15/10	Mon 2/15/10		
370	Backlog Prioritization	0%	1 day?	Mon 2/15/10	Mon 2/15/10		
371	Documentation Review	0%	1 day?	Mon 2/15/10	Mon 2/15/10		
372	**Deliverables**	**0%**	**9 days?**	**Tue 2/16/10**	**Fri 2/26/10**		
373	Integration Testing	0%	9 days?	Tue 2/16/10	Fri 2/26/10		KMR Team,Fateh
374	Demonstration at HIMSS Meeting	0%	3 days	Mon 3/1/10	Wed 3/3/10		
375	**Release #3**	**0%**	**70 days?**	**Mon 3/8/10**	**Fri 6/11/10**		
376	**Sprint 28 (Milestone Editor Release #1)**	**0%**	**10 days?**	**Mon 3/8/10**	**Fri 3/19/10**		
377	**Sprint Planning**	**0%**	**1 day?**	**Mon 3/8/10**	**Mon 3/8/10**		
378	User Story Additions	0%	1 day?	Mon 3/8/10	Mon 3/8/10		
379	Backlog Prioritization	0%	1 day?	Mon 3/8/10	Mon 3/8/10		
380	Documentation Review	0%	1 day?	Mon 3/8/10	Mon 3/8/10		
381	**Deliverables**	**0%**	**9 days?**	**Tue 3/9/10**	**Fri 3/19/10**		
382	Release #1 for Milestone Editor as NHIN Client	0%	9 days?	Tue 3/9/10	Fri 3/19/10		KMR Team,Fateh
383	**Sprint 29 (Patient Portal Release #1)**	**0%**	**10 days?**	**Mon 3/22/10**	**Fri 4/2/10**		
384	**Sprint Planning**	**0%**	**1 day?**	**Mon 3/22/10**	**Mon 3/22/10**		
385	User Story Additions	0%	1 day?	Mon 3/22/10	Mon 3/22/10		

ID	Task Name	% Work Complete	Duration	Start	Finish	Predecessors	Resource Names
386	Backlog Prioritization	0%	1 day?	Mon 3/22/10	Mon 3/22/10		
387	Documentation Review	0%	1 day?	Mon 3/22/10	Mon 3/22/10		
388	**Deliverables**	**0%**	**9 days?**	**Tue 3/23/10**	**Fri 4/2/10**		
389	Release #1 for Patient Portal as NHIN Client	0%	9 days?	Tue 3/23/10	Fri 4/2/10		KMR Team,Fateh
390	**Sprint 30 (Mobile Tools Release #1)**	**0%**	**10 days?**	**Mon 4/5/10**	**Fri 4/16/10**		
391	**Sprint Planning**	**0%**	**1 day?**	**Mon 4/5/10**	**Mon 4/5/10**		
392	User Story Additions	0%	1 day?	Mon 4/5/10	Mon 4/5/10		
393	Backlog Prioritization	0%	1 day?	Mon 4/5/10	Mon 4/5/10		
394	Documentation Review	0%	1 day?	Mon 4/5/10	Mon 4/5/10		
395	**Deliverables**	**0%**	**9 days?**	**Tue 4/6/10**	**Fri 4/16/10**		
396	Release #1 for Mobile Tools as NHIN Client	0%	9 days?	Tue 4/6/10	Fri 4/16/10		KMR Team,Fateh
397	**Sprint 31 (MedAlert Release #2)**	**0%**	**10 days?**	**Mon 4/19/10**	**Fri 4/30/10**		
398	**Sprint Planning**	**0%**	**1 day?**	**Mon 4/19/10**	**Mon 4/19/10**		
399	User Story Additions	0%	1 day?	Mon 4/19/10	Mon 4/19/10		
400	Backlog Prioritization	0%	1 day?	Mon 4/19/10	Mon 4/19/10		
401	Documentation Review	0%	1 day?	Mon 4/19/10	Mon 4/19/10		
402	**Deliverables**	**0%**	**9 days?**	**Tue 4/20/10**	**Fri 4/30/10**		
403	Release #2 MedAlert as NHIN Client	0%	9 days?	Tue 4/20/10	Fri 4/30/10		KMR Team,Fateh
404	**Sprint 32 (Drools Optimizations Release # 1)**	**0%**	**11 days?**	**Mon 5/3/10**	**Mon 5/17/10**		
405	**Sprint Planning**	**0%**	**1 day?**	**Mon 5/3/10**	**Mon 5/3/10**		
406	User Story Additions	0%	1 day?	Mon 5/3/10	Mon 5/3/10		
407	Backlog Prioritization	0%	1 day?	Mon 5/3/10	Mon 5/3/10		
408	Documentation Review	0%	1 day?	Mon 5/3/10	Mon 5/3/10		
409	**Deliverables**	**0%**	**9 days?**	**Wed 5/5/10**	**Mon 5/17/10**		
410	Release #1 Drools Optimizations	0%	9 days?	Wed 5/5/10	Mon 5/17/10		KMR Team,Fateh

ID	Task Name	% Work Complete	Duration	Start	Finish	Predecessors	Resource Names
411	**Sprint 33 (Community Portal Release # 1)**	**0%**	**10 days?**	**Mon 5/17/10**	**Fri 5/28/10**		
412	**Sprint Planning**	**0%**	**1 day?**	**Mon 5/17/10**	**Mon 5/17/10**		
413	User Story Additions	0%	1 day?	Mon 5/17/10	Mon 5/17/10		
414	Backlog Prioritization	0%	1 day?	Mon 5/17/10	Mon 5/17/10		
415	Documentation Review	0%	1 day?	Mon 5/17/10	Mon 5/17/10		
416	**Deliverables**	**0%**	**9 days?**	**Tue 5/18/10**	**Fri 5/28/10**		
417	Release #1 Community Portal as NHIN Client	0%	9 days?	Tue 5/18/10	Fri 5/28/10		KMR Team,Fateh
418	**Sprint 34 (Integration Testing)**	**0%**	**9 days?**	**Tue 6/1/10**	**Fri 6/11/10**		
419	**Sprint Planning**	**0%**	**1 day?**	**Tue 6/1/10**	**Tue 6/1/10**		
420	User Story Additions	0%	1 day?	Tue 6/1/10	Tue 6/1/10		
421	Backlog Prioritization	0%	1 day?	Tue 6/1/10	Tue 6/1/10		
422	Documentation Review	0%	1 day?	Tue 6/1/10	Tue 6/1/10		
423	**Deliverables**	**0%**	**8 days?**	**Wed 6/2/10**	**Fri 6/11/10**		
424	Integration Testing	0%	8 days?	Wed 6/2/10	Fri 6/11/10		KMR Team,Fateh
425	**Release #4**	**0%**	**80 days?**	**Mon 6/14/10**	**Fri 10/1/10**		
426	**Sprint 35 (Patient Portal Release #2)**	**0%**	**10 days?**	**Mon 6/14/10**	**Fri 6/25/10**		
427	**Sprint Planning**	**0%**	**1 day?**	**Mon 6/14/10**	**Mon 6/14/10**		
428	User Story Additions	0%	1 day?	Mon 6/14/10	Mon 6/14/10		
429	Backlog Prioritization	0%	1 day?	Mon 6/14/10	Mon 6/14/10		
430	Documentation Review	0%	1 day?	Mon 6/14/10	Mon 6/14/10		
431	**Deliverables**	**0%**	**9 days?**	**Tue 6/15/10**	**Fri 6/25/10**		
432	Release #2 Patient Portal as NHIN Client	0%	9 days?	Tue 6/15/10	Fri 6/25/10		KMR Team,Fateh
433	**Sprint 36 (Community Portal Release # 2)**	**0%**	**10 days?**	**Mon 6/28/10**	**Fri 7/9/10**		
434	**Sprint Planning**	**0%**	**1 day?**	**Mon 6/28/10**	**Mon 6/28/10**		
435	User Story Additions	0%	1 day?	Mon 6/28/10	Mon 6/28/10		

ID	Task Name	% Work Complete	Duration	Start	Finish	Predecessors	Resource Names
436	Backlog Prioritization	0%	1 day?	Mon 6/28/10	Mon 6/28/10		
437	Documentation Review	0%	1 day?	Mon 6/28/10	Mon 6/28/10		
438	**Deliverables**	**0%**	**9 days?**	**Tue 6/29/10**	**Fri 7/9/10**		
439	Release #2 Community Portal Release as NHIN Client	0%	9 days?	Tue 6/29/10	Fri 7/9/10		KMR Team,Fateh
440	**Sprint 37 (Drools Optimizations Release # 2)**	**0%**	**10 days?**	**Mon 7/12/10**	**Fri 7/23/10**		
441	**Sprint Planning**	**0%**	**1 day?**	**Mon 7/12/10**	**Mon 7/12/10**		
442	User Story Additions	0%	1 day?	Mon 7/12/10	Mon 7/12/10		
443	Backlog Prioritization	0%	1 day?	Mon 7/12/10	Mon 7/12/10		
444	Documentation Review	0%	1 day?	Mon 7/12/10	Mon 7/12/10		
445	**Deliverables**	**0%**	**9 days?**	**Tue 7/13/10**	**Fri 7/23/10**		
446	Release #2 Drools Optimizations	0%	9 days?	Tue 7/13/10	Fri 7/23/10		KMR Team,Fateh
447	**Sprint 38 (Milestone Editor Release #2)**	**0%**	**10 days?**	**Mon 8/9/10**	**Fri 8/20/10**		
448	**Sprint Planning**	**0%**	**1 day?**	**Mon 8/9/10**	**Mon 8/9/10**		
449	User Story Additions	0%	1 day?	Mon 8/9/10	Mon 8/9/10		
450	Backlog Prioritization	0%	1 day?	Mon 8/9/10	Mon 8/9/10		
451	Documentation Review	0%	1 day?	Mon 8/9/10	Mon 8/9/10		
452	**Deliverables**	**0%**	**9 days?**	**Tue 8/10/10**	**Fri 8/20/10**		
453	Release #2 Milestone Editor as NHIN Client	0%	9 days?	Tue 8/10/10	Fri 8/20/10		KMR Team,Fateh
454	**Sprint 39 (Mobile Tools Release Release #2)**	**0%**	**10 days?**	**Mon 8/23/10**	**Fri 9/3/10**		
455	**Sprint Planning**	**0%**	**1 day?**	**Mon 8/23/10**	**Mon 8/23/10**		
456	Backlog Prioritization	0%	1 day?	Mon 8/23/10	Mon 8/23/10		
457	Documentation Review	0%	1 day?	Mon 8/23/10	Mon 8/23/10		
458	**Deliverables**	**0%**	**9 days?**	**Tue 8/24/10**	**Fri 9/3/10**		
459	Release #2 Mobile Tools	0%	9 days?	Tue 8/24/10	Fri 9/3/10		KMR Team,Fateh
460	**Sprint 40 (Final Integration Testing)**	**0%**	**9 days?**	**Tue 9/7/10**	**Fri 9/17/10**		

ID	Task Name	% Work Complete	Duration	Start	Finish	Predecessors	Resource Names
461	**Sprint Planning**	**0%**	**9 days?**	**Tue 9/7/10**	**Fri 9/17/10**		
462	**User Story Additions**	**0%**	**1 day?**	**Tue 9/7/10**	**Tue 9/7/10**		
463	Backlog Prioritization	0%	1 day?	Tue 9/7/10	Tue 9/7/10		
464	Documentation Review	0%	1 day?	Tue 9/7/10	Tue 9/7/10		
465	**Deliverables**	**0%**	**8 days**	**Wed 9/8/10**	**Fri 9/17/10**		
466	Final Integration Testing	0%	8 days	Wed 9/8/10	Fri 9/17/10		KMR Team,Fateh
467	**Sprint 41 (Final Demonstration)**	**0%**	**10 days?**	**Mon 9/20/10**	**Fri 10/1/10**		
468	**Sprint Planning**	**0%**	**1 day?**	**Mon 9/20/10**	**Mon 9/20/10**		
469	User Story Additions	0%	1 day?	Mon 9/20/10	Mon 9/20/10		
470	Backlog Prioritization	0%	1 day?	Mon 9/20/10	Mon 9/20/10		
471	Documentation Review	0%	1 day?	Mon 9/20/10	Mon 9/20/10		
472	**Deliverables**	**0%**	**9 days?**	**Tue 9/21/10**	**Fri 10/1/10**		
473	Final Demonstration	0%	9 days?	Tue 9/21/10	Fri 10/1/10		KMR Team,Fateh
474	**Pilot Demonstration**	**7%**	**267 days?**	**Mon 8/31/09**	**Fri 9/3/10**		
475	**Pilot Initiation**	**15%**	**85 days?**	**Mon 8/31/09**	**Wed 12/23/09**		
476	Pilot Concept Proposal	100%	1 day	Mon 8/31/09	Mon 8/31/09		ASU
477	Draft Pilot Project Plan	15%	52 days?	Mon 10/5/09	Fri 12/11/09		ASU,Terry,Nan,Howard,Trish
478	Final Pilot Project Plan	0%	8 days?	Mon 12/14/09	Wed 12/23/09		
479	**Phoenix Indian Medical Center Pilot**	**0%**	**234 days?**	**Thu 10/15/09**	**Fri 9/3/10**		**Doug and Connie**
480	**Community Outreach**	**0%**	**99 days?**	**Thu 10/15/09**	**Fri 2/26/10**		
481	**Phase 1: Plan Community Involvement**	**0%**	**34 days?**	**Thu 10/15/09**	**Fri 11/27/09**		
482	Identify Stakeholders	0%	1 day?	Thu 10/15/09	Thu 10/15/09		
483	Community Outreach Concept Paper	0%	1 day?	Fri 10/16/09	Fri 10/16/09		
484	First Executive Community Steering Group Meeting	0%	1 day?	Fri 11/27/09	Fri 11/27/09		Nan
485	**Phase 2: Execute Community Outreach**	**0%**	**14 days?**	**Mon 1/11/10**	**Thu 1/28/10**		

ID	Task Name	% Work Complete	Duration	Start	Finish	Predecessors	Resource Names
486	**Community Advisory Board**	**0%**	**1 day?**	**Mon 1/11/10**	**Mon 1/11/10**		**Nan**
487	Community Advisory Board #1	0%	1 day?	Mon 1/11/10	Mon 1/11/10		
488	**Town hall Meetings**	**0%**	**1 day?**	**Mon 1/25/10**	**Mon 1/25/10**		**Howard Hayes,Nan**
489	Town hall Meeting #1	0%	1 day?	Mon 1/25/10	Mon 1/25/10		Nan
490	**Community Focus Groups**	**0%**	**1 day?**	**Tue 1/26/10**	**Tue 1/26/10**		
491	Community Focus Group Meeting #1	0%	1 day?	Tue 1/26/10	Tue 1/26/10		
492	**Provider Focus Groups**	**0%**	**1 day?**	**Wed 1/27/10**	**Wed 1/27/10**		
493	Provider Focus Group Meeting #1	0%	1 day?	Wed 1/27/10	Wed 1/27/10		
494	**Medical Center Briefings**	**0%**	**1 day?**	**Thu 1/28/10**	**Thu 1/28/10**		
495	IT Staff Briefing #1	0%	1 day?	Thu 1/28/10	Thu 1/28/10		
496	**Phase 3: Community Needs Assessment**	**0%**	**1 day?**	**Fri 2/26/10**	**Fri 2/26/10**		
497	Identify test group	0%	1 day?	Fri 2/26/10	Fri 2/26/10		
498	**Pilot Preparation**	**0%**	**20 days?**	**Mon 3/1/10**	**Fri 3/26/10**		
499	**Clinical Decision Support**	**0%**	**20 days?**	**Mon 3/1/10**	**Fri 3/26/10**		
500	CDS Protocol Identification	0%	20 days?	Mon 3/1/10	Fri 3/26/10		
501	CDS Content	0%	20 days?	Mon 3/1/10	Fri 3/26/10		
502	**Deployment Plan**	**0%**	**20 days?**	**Mon 3/1/10**	**Fri 3/26/10**		
503	Establish Production Architecture	0%	20 days?	Mon 3/1/10	Fri 3/26/10		
504	Production Hardware Requirements	0%	20 days?	Mon 3/1/10	Fri 3/26/10		
505	**Training Plan**	**0%**	**20 days?**	**Mon 3/1/10**	**Fri 3/26/10**		
506	Training Objectives	0%	20 days?	Mon 3/1/10	Fri 3/26/10		
507	Training Resources	0%	20 days?	Mon 3/1/10	Fri 3/26/10		
508	Training Strategy	0%	20 days?	Mon 3/1/10	Fri 3/26/10		
509	Training Content	0%	20 days?	Mon 3/1/10	Fri 3/26/10		
510	**Communication Plan**	**0%**	**20 days?**	**Mon 3/1/10**	**Fri 3/26/10**		

ID	Task Name	% Work Complete	Duration	Start	Finish	Predecessors	Resource Names
511	Draft Communication Management Plan	0%	20 days?	Mon 3/1/10	Fri 3/26/10		
512	Review and Revise	0%	20 days?	Mon 3/1/10	Fri 3/26/10		
513	Communication Plan Approved	0%	20 days?	Mon 3/1/10	Fri 3/26/10		
514	Implement Communication Management Process	0%	20 days?	Mon 3/1/10	Fri 3/26/10		
515	**Evaluation Plan**	**0%**	**20 days?**	**Mon 3/1/10**	**Fri 3/26/10**		
516	System Metrics	0%	20 days?	Mon 3/1/10	Fri 3/26/10		
517	Patient feedback	0%	20 days	Mon 3/1/10	Fri 3/26/10		
518	Community feedback	0%	20 days	Mon 3/1/10	Fri 3/26/10		
519	Provider feedback	0%	20 days	Mon 3/1/10	Fri 3/26/10		
520	**HIS Certification & Authorization**	**0%**	**70 days?**	**Mon 3/29/10**	**Fri 7/2/10**		
521	Costing Plan	0%	70 days?	Mon 3/29/10	Fri 7/2/10		
522	Secure deployment resources	0%	70 days?	Mon 3/29/10	Fri 7/2/10		
523	Deployment Architecture	0%	70 days?	Mon 3/29/10	Fri 7/2/10		
524	**Pilot Deployment**	**0%**	**67 days?**	**Thu 4/1/10**	**Fri 7/2/10**		
525	Identify each component	0%	67 days?	Thu 4/1/10	Fri 7/2/10		
526	Costing	0%	67 days?	Thu 4/1/10	Fri 7/2/10		
527	Secure deployment resources	0%	67 days?	Thu 4/1/10	Fri 7/2/10		
528	Establish Help Desk	0%	67 days?	Thu 4/1/10	Fri 7/2/10		
529	Deploy software	0%	67 days?	Thu 4/1/10	Fri 7/2/10		
530	Deployment complete	0%	67 days?	Thu 4/1/10	Fri 7/2/10		
531	**Pilot Evaluation**	**0%**	**45 days?**	**Mon 7/5/10**	**Fri 9/3/10**		
532	Data Collection	0%	45 days?	Mon 7/5/10	Fri 9/3/10		
533	System Metrics	0%	45 days?	Mon 7/5/10	Fri 9/3/10		
534	Patient feedback	0%	45 days?	Mon 7/5/10	Fri 9/3/10		
535	Provider feedback	0%	45 days?	Mon 7/5/10	Fri 9/3/10		ASU
536	Community feedback	0%	45 days	Mon 7/5/10	Fri 9/3/10		

ID	Task Name	% Work Complete	Duration	Start	Finish	Predecessors	Resource Names
536	Community feedback	0%	45 days	Mon 7/5/10	Fri 9/3/10		
537	**Project Wtrap-Up**	**0%**	**19 days**	**Mon 9/6/10**	**Thu 9/30/10**		
538	**Project Documentation**	**0%**	**19 days**	**Mon 9/6/10**	**Thu 9/30/10**		
539	Functional Requirements, Use Cases, and Academic Review (Deliverable #2)	0%	19 days	Mon 9/6/10	Thu 9/30/10		
540	System Design Specification and Academic Review (Deliverable #3)	0%	19 days	Mon 9/6/10	Thu 9/30/10		
541	User Documentation (Deliverable #4)	0%	19 days	Mon 9/6/10	Thu 9/30/10		
542	Metadata (Deliverable #6)	0%	19 days	Mon 9/6/10	Thu 9/30/10		
543	Final Report	0%	19 days	Mon 9/6/10	Thu 9/30/10		
544	**KMR Deliverables**	**0%**	**19 days**	**Mon 9/6/10**	**Thu 9/30/10**		
545	**Metadata (Deliverable #6)**	**0%**	**19 days**	**Mon 9/6/10**	**Thu 9/30/10**		
546	Develop information model based on functional and semantic requirements of use cases	0%	19 days	Mon 9/6/10	Thu 9/30/10		
547	Identify standardized terminologies for value sets or crate "placeholder" value sets for concepts	0%	19 days	Mon 9/6/10	Thu 9/30/10		
548	**Code Delivery**	**0%**	**19 days**	**Mon 9/6/10**	**Thu 9/30/10**		
549	KMR Repository and Guideline Content Mgt System Delivered (Deliverable #7)	0%	19 days	Mon 9/6/10	Thu 9/30/10		
550	Rule and Guideline Runtime Engine Delivered (Deliverable #8)	0%	19 days	Mon 9/6/10	Thu 9/30/10		
551	Sys Adm Portal and Performance Monitoring Tool Delivered (Deliverable #9)	0%	19 days	Mon 9/6/10	Thu 9/30/10		
552	Point of Care CDS Tools for AHLTA Delivered (Deliverable #10)	0%	19 days	Mon 9/6/10	Thu 9/30/10		
553	Guideline/Rules Workbench and Authoring Tools Delivered (Deliverable #11)	0%	19 days	Mon 9/6/10	Thu 9/30/10		

KNOWLEDGE MANAGEMENT REPOSITORY (KMR)
For CLINICAL DECISION SUPPORT (CDS) and PROOF OF CONCEPT
For AUTOMATED CLINICAL PRACTICE GUIDELINE (aCPG) EXECUTION
WITHIN AHLTA

	Deliverable			Resource	Projected Delivery Date	Date Delivered
	AIM #1 – Engineering Documentation a) Requirement and Analysis and Project Plan					
1	Project Documentation and Engineering Plans	1a 1b 1c	Project Plan Deliverable Table Engineering Plan • Release 1 • Release 2 • Release 3 • Release 4 - Final	Patricia Price Patricia Price SOADEX SOADEX SOADEX SOADEX	08/26/2009 09/30/2009 11/13/2009 02/26;/2010 06/11/2010 09/30/2010	09/30/2009 09/30/2009
2	Functional Requirements and Use Cases Academic Review			SOADEX SOADEX	06/05/2009 10/15//2009	06/05/2009
	AIM #1 Engineering Documentation b) System Architecture, Technical Design and QA Plan					
3	System Design Specification Academic Review			SOADEX SOADEX	08/14/2009 11/14/2009	08/14/2009
4	User Documentation			KMR Team	02/26/2010	
5	System Test, Integration and QA Plans			SOADEX	11/25/2009	
6	Metadata, Terminologies and Value Sets			ASU	11/30//2010	
	AIM #2 – Implementation of the KMR and CDS Infrastructure					
7	KMR Repository and Guideline Content Management System			KMR Team	02/12/2010	
8	Rule and Guideline Runtime Engine			KMR Team	01/15/2010	

9	System Administration Portal and Performance Monitoring Tool	KMR Team	12/24/2009	
10	Point of Care CDS Tools for AHLTA • MedAlert ➢ Release 1 ➢ Release 2 – Final Release • Milestone Editor ➢ Release 1 ➢ Release 2 – Final Release • Patient Portal ➢ Release 1 ➢ Release 2 – Final Release • Mobile Tools ➢ Release 1 ➢ Release 2 – Final Release	 KMR Team KMR Team KMR Team KMR Team KMR Team KMR Team KMR Team KMR Team	 10/30/2009 02/12/2010 03/19/2010 08/20/2010 04/02/2010 06/25/2010 04/16/2010 09/17/2010	
11	Guideline/Rules Workbench and Authoring Tools • Guideline/Rules Workbench ➢ Release 1 ➢ Release 2 – Final Release • Milestone Editor ➢ Release 1 ➢ Release 2 – Final Release • Community Portal ➢ Release 1 ➢ Release 2 – Final Release	 KMR Team KMR Team KMR Team KMR Team KMR Team KMR Team	 12/11/2009 01/2920/09 03/19/2010 09/20/2010 05/28/2010 07/09/2010	
	AIM #3 – Development of Executable Guidelines			
12	Content and Executable Clinical Guidelines for TBI, PTSD, and Diabetes	ASU	03/01/2010	
	AIM #4 – Development of Executable Guidelines			
13	Academic presentation & demonstration of runtime deliverables	ASU	03/01/2010	
	AIM #5 – Comparative Research & Academic Publication			
14	Academic review of current CDS 'state of the art'	ASU	03/01/2010	
15	Academic panel discussion on future state CDS requirements	ASU	11/15/2009	
16	Academic review of completed KMR Project	ASU	09/30/2010	
17	Academic outcome & usability evaluations	ASU	09/30/2010	